SURVEYING AND MAPPING

Aaron L. Shalowitz, *Editor*

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Special Announcement

Prize Awards for Best Articles, 1947

THE American Congress on Surveying and Mapping, in order to encourage the preparation of articles for SURVEYING AND MAPPING, announces the establishment of cash awards to be made for the best articles submitted on any subject pertaining to surveying and mapping. To be eligible for the prizes, articles must be submitted during the period June 1st to December 31st, 1947.

FIRST PLACE AWARD—$100
SECOND PLACE AWARD—$50

The following rules will govern the contest:

(1) Members of the Congress—except officers of the Congress and members of the Special Prize Contest Committee—and others are eligible to submit one or more articles.

(2) Any unpublished original article, technical or non-technical, which deals with any branch of surveying or mapping or their related fields, including personal experiences on difficult or unusual survey projects, new methods, new developments in instruments or techniques, map reproduction processes, and historical and exploratory developments in the field of surveying and mapping, will be considered.

(3) Articles shall contain not less than 2000 and not more than 4000 words, shall be typewritten, double-spaced, on one side of paper 8½ by 11 inches, and must be submitted in triplicate, each copy complete in itself. Appropriate photographs, sketches, or other illustrations may be submitted.

(4) The contest will run from June 1 to December 31, 1947, but articles submitted may be used for publication currently as received or subsequent to the close of the contest. No articles submitted will be returned. All articles must be postmarked prior to midnight, December 31, 1947.

(5) All entries should be mailed direct to: Prof. George H. Harding, Chairman, Special Prize Contest Committee, ACSM, Room 406 Engineering Experiment Station, Ohio State University, Columbus 10, Ohio. Each article shall be accompanied by a letter of transmittal stating that the article is submitted as an entry for the special prize awards.

(6) Articles will be judged on the basis of content, clearness of presentation, interest, originality, and attention to detail in preparation.

(7) Notice of award winners will be published in SURVEYING AND MAPPING, and the awards will be presented as soon as practicable after December 31, 1947.

(8) The decision of the Special Prize Contest Committee will be final.

THE EXECUTIVE COMMITTEE

January • June • 1947

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Seventh Annual Meeting

AUGUST 14–15TH—HOTEL STATLER—WASHINGTON, D. C.

THE SEVENTH ANNUAL MEETING of the American Congress on Surveying and Mapping has been set for August 14 and 15, 1947. The change from the usual June meeting has been made in order to afford a better opportunity for members of the educational profession to attend.

A program of special professional interest and importance is being planned for the two-day meeting. There will be two panel discussions on the first day: (1) on debatable subjects of surveying and engineering education, and (2) on the problems and policies of modern property surveys. The second day will be devoted to the presentation of papers on timely subjects of national and international interest by prominent leaders in the surveying and mapping fields.

An extensive exhibit of instrumental equipment and materials by leading domestic and foreign manufacturers is planned for the meeting. The annual dinner will be held on the evening of August 14 and will include appropriate entertainment.

Hotel reservations will be available and arrangements should be made through Murray Y. Poling, Chairman, Committee on Arrangements, Room 2814–B, Department of Commerce Bldg., Washington 25, D. C.

THE EXECUTIVE COMMITTEE

Maps and the Needs of Our National Welfare

By REAR ADMIRAL LEO OTIS COLBERT
DIRECTOR, UNITED STATES COAST AND GEODETIC SURVEY

ALTHOUGH we emerged from World War II a more map-conscious America, there has not yet developed a sufficient crystallization of public sentiment for a large-scale accelerated mapping program. Militarily the need for maps and charts has been brought home to those in the Armed Services who piloted our ships, guided our bombers, and directed our foot soldiers. This same consciousness of the military importance of maps has been passed on to a large segment of our civilian population. But the place of maps in our peacetime economy is still understood by only the relatively few whose profession or business has made them aware of the vast benefits to be derived from a well-mapped country.

Mapping a Prime Necessity for National Welfare

America is today the wealthiest nation in the world. We are rich in natural resources and we have a high engineering potential for exploring those resources. We are the inheritors of 3,000,000 square miles of land with millions of acres of fertile soil, a wealth of forests, rivers, and streams, and mineral resources of all kinds—the essentials for maintaining life and for providing means of producing and distributing needed goods. Yet we lack the basic information necessary for their effective utilization and conservation, because we have failed to provide ourselves with complete and adequate maps of our country.

It is this very tangible relationship between maps and our national welfare that is not generally understood.

Mapping is a fact-finding operation and maps are the indispensable tools of ordered progress. Intelligent national, state, or municipal planning is impossible without adequate maps. The development of drainage, flood control, irrigation projects, water supply, and power developments; the location of railways, highways, property lines, sewers, canals, transmission lines, parks, and recreation centers; and an endless variety of other engineering, industrial, and civic developments are peculiarly dependent on good topographic maps.

Abundant evidence could be presented to prove the actual dollars and cents savings that would have accrued to the taxpayer had adequate maps been available. Some years ago the Association of State Highway Officials stated that "the saving in the expenditure of highway funds entrusted to our supervision, if these topographic maps were available for our use, would be much greater than the cost of making them." Recently officials of the Pacific Gas and Electric Company indicated that adequate maps of the Pit, Feather, Bear, and Stanislaus Rivers would have saved the company $200,000. Similar statements by officials of government and private industry can be found in almost any of the reports issued by Planning Boards and other organizations in recent years.

Reprinted through the courtesy of *Think* Magazine, December 1946.

FIGURE 1.—Portable steel towers are used to elevate the instruments in triangulation.

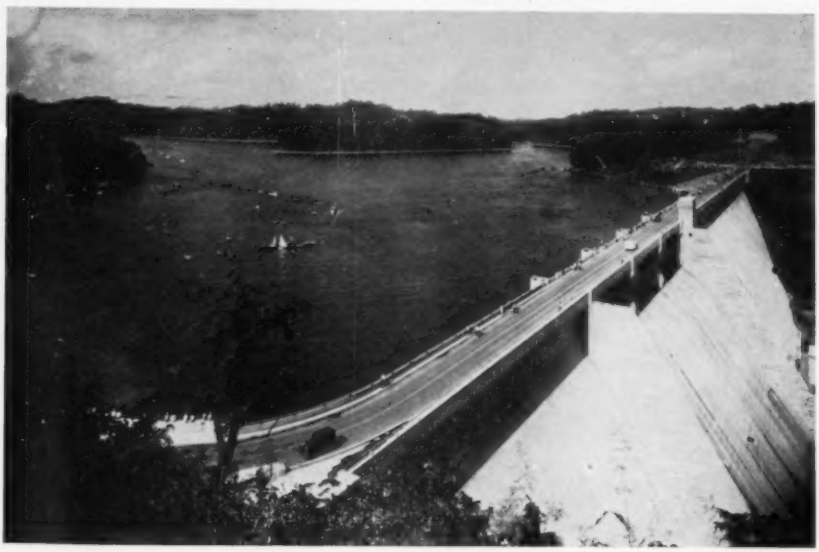
MAPPING IN THE UNITED STATES

The history of mapping in the United States goes back to the early days of the Republic. The Congressional Resolutions of July 25, 1777, authorized General Washington to appoint a "geographer and surveyor of the roads, to take sketches of the country, the seat of war. . . ." The first recognition of the need for a systematic survey of our country came in 1807 when the United States Coast Survey (later changed to the United States Coast and Geodetic Survey) was organized to make surveys of the land area along our coasts and to survey and chart the water areas contiguous thereto. With the Nation's growth this work was expanded to provide, across the entire country, a fundamental network of control (latitudes and longitudes of permanently marked points) on which all land surveys and engineer-

FIGURE 2.—The Fathometer, an instrument used for measuring depths at sea by sound.

Montana State Highway Department

FIGURE 3.—U. S. No. 10, Montana. The selection of the most economic route for a highway requires good topographic maps.



Tennessee Valley Authority

FIGURE 4.—Norris Dam, Tennessee. Maps were an important factor in this great development project.

ing projects—whether federal, state, municipal, or private—could be based. It is because of this very practical control-survey job that a series of charts and maps covering the United States may be put together like the many pieces of a picture puzzle.

The Congressional Act of March 3, 1879, marked another important development in the history of systematic mapping in this country. That act created the United States Geological Survey for the purpose of classifying the public lands and examining the geologic structure of the public domain. As the need for adequate topographic maps for all mapping investigations became evident the work of the Survey was extended to include the preparation of a topographic atlas of the United States, so designed that all maps produced would be component parts of the whole.

Besides these two principal mapping agencies other federal map-using agencies such as the Soil Conservation Service, the Forest Service, and the Army Engineers, have in more recent years contributed to the program of mapping the country by preparing maps to meet their special needs.

Present Status of Mapping

Notwithstanding this long history, we are still in a greatly inferior mapping position. This inadequate situation was emphasized after Pearl Harbor and we frantically embarked on a program to improve conditions in areas of strategic importance because defensive operation in the continental United States was recognized as a possibility.

In contrast with our neglect of mapping, other leading countries of the world—particularly those of western Europe—have long ago provided themselves with topographic maps adequate both for military purposes and for internal improvements, and they are constantly engaged in modernizing and improving existing maps. We have been progressing during these many decades at very inadequate rates on the production of the standard map of the United States. This standard map conceives as one unit the charts of our coastal waters and the topographic maps of the interior. Large areas covered by our present coastal charts were surveyed 40 to 50 years ago. Apart from the changes (both natural and artificial) that have taken place in many of the inshore areas, many of our early surveys in deep water—such as in the region of the Continental Shelf—are now obsolete because they lack the detailed information required for modern navigation, as well as for the proper exploration of the natural resources these areas are known to contain.

In the interior of the country the mapping situation is even less satisfactory. Considerably less than half of continental United States has been adjudged adequately mapped as measured by present-day engineering requirements. On this basis of appraisal slightly over half of highly industrialized Pennsylvania would be included, about 12 percent of Colorado, and about 38 percent of California—to mention but a few specific cases. In many sections of the country no maps at all exist. At the past rate of progress it would take well over a hundred years before the country's topographic map could even begin to be completed.

With the coming of peace the federal mapping agencies have once again evaluated our mapping position and have prepared programs for its improvement.

In connection with these programs, it should be remembered that no program of mapping can be considered fixed. We are a growing and developing country,

and a modern mapping program must be responsive to the changing needs of the map user, as it must keep pace with our commercial and industrial progress. There is a demand for larger-scale maps and for a greater co-ordination of urban engineering surveys with our national network of triangulation. As our program for a nation-wide development of our great river valleys gains momentum, more surveys and maps will be needed from which blueprints can be prepared for planned projects.

Industry has designed and produced improved types of instruments during the past few years, many of which have been adapted to surveying and mapping needs. New techniques have also been developed. These developments will increase the economy of operation and permit greater production of maps and charts.

* * *

Polar Expedition Finds Swain Island a Myth

SWAIN ISLAND, recorded on all maps of the Antarctic Ocean for more than 100 years, became a ghostly myth today.

Supposedly lying about 1000 miles west of the southern tip of South America, the island was proved to be nonexistent when the South Pole expedition's Western Task Force made sonic depth testings.

The discovery was made as the Task Force pushed southward through icebergs into forbidding Bellinghausen Sea, with its great fields of pack ice reaching to the coast of Antaretica.

Swain Island apparently was the ice-born hallucination of Jonathan Swain, New Bedford sealer, who sailed these seas in the good ship *Marcia* in 1827. He recorded the precise position of a large island, surrounded by fields of red water, with a radius of more than 10 miles and alive with thousands of migratory birds. His account was so detailed it was generally accepted by geographers. Few ships since have followed Swain's path and none passing in the vicinity had been able to sight his island.

In absence of specific proof to the contrary, the old sealer was given the benefit of doubt, especially since six other ships over a period of 20 years reported the great red kelp fields extending over areas of square miles. These are due to swarming on a species of small crustacean and usually indicate land near at hand.

The Task Force was instructed to settle the question once and for all by investigations on the precise spot with the newest scientific apparatus. The determination leaves more than 3000 square miles of sea landless, with the possible exception of tiny Macy's Island, also reported by a New Bedford sealer more than a century ago and which also may prove an hallucination. The good faith of the old sealers is not impugned. The Bellinghausen Sea, of which the ghost island was a northern sentinel, is a sea of mirages. Islands and mountains beyond the horizon, through a strange optical phenomenon, seem to be picked up bodily and set down close at hand. They appear in minute detail like pictures projected on a screen.

Of all the world's mirage-haunted oceans, Bellinghausen's Sea is the most haunted. Fantastic forms of thin air move on its sunlit and moonlit waters. More than 100 years ago they bothered bluff old Count Bellinghausen, leader of the Russian expedition which met the first American explorers on Antarctic shores. Due to this phenomenon, some of his own discoveries as well as those of the American, Charles Wilkes, have been questioned. —Thomas R. Henry, writing from Antaretica, in *The Washington Evening Star*, December 25, 1946.

Where Do We Go From Here?

By GERALD FITZGERALD
STAFF TOPOGRAPHIC ENGINEER, U. S. GEOLOGICAL SURVEY

I SHOULD like to say first—and it is probably unnecessary—that not by the widest stretch of the imagination can I be called an expert in the field of electronics. All of us who are engaged in surveying and mapping have been intrigued with the idea that the use of electronics might assist us in establishing geographic control. I must confess today that I am more than a little disappointed in the development of electronic surveying that has taken place in the last 3 or 4 years. That hydrographers have made some progress in connection with their own work has been indicated by the papers delivered this morning. This work in connection with hydrographic survey operations was done by the Coast and Geodetic Survey in Alaska. Unquestionably this is an important contribution and perhaps points the way to additional work in hydrographic surveying and to some extent in the control for topographic mapping.

In connection with the use of electronics in aerial photogrammetry, the Army Air Forces Aeronautical Chart Service, as early as 1943, became very much interested in the application of Radar to the problem of establishing some kind of control for reconnaissance mapping. That organization was engaged in a project, as many of you know, that required reconnaissance mapping in many parts of the world for the preparation of small-scale aeronautical charts. One of the first major problems was the establishment of ground control for photographic compilation. Large numbers of trained and partially trained observers were sent into the field with various types of instruments, including the prismatic astrolabe and zenith camera to determine astronomic positions. The cost of this program ran into millions of dollars. Much valuable information was obtained—as a matter of fact, islands and important towns were found to be out of position by as much as 30 or 40 miles. A course plotted on such inaccurate charts by a pilot who was trying to find an airport would be, and often was, disastrous. As Commanding Officer of the Aeronautical Chart Service during the war years, I personally beat the corridors of the Pentagon Building in an effort to get support for establishment within the framework of the 311th Wing of a unit which would take the promise of electronics and apply it to our problem of reconnaissance mapping. We had to determine cheaply and quickly the positions with which to prepare aeronautical charts from aerial photographs for immediate operational use. It took a long time to get this program started with the basic equipment and personnel required to carry on the work.

Two years ago Brigadier Hotine of the Geographic Section of the General Staff, War Office, London, as I recall it, published a paper in which he stated that experimental work in England led them to believe that the development of Radar with aerial photography indicated that the preparation of operational maps at a scale of 1:50,000 and even 1:25,000 was feasible under ideal conditions. He stated further that the development was already adequate for the preparation of controlled mosaics. I frankly don't see where we in this country have utilized

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this technique to meet our first military requirement for reconnaissance maps. Maybe it was not practical; perhaps it was essential first to determine whether refinements could be made which would enable Shoran to compete with second- or first-order triangulation. It does not seem to me that this should have been necessary since our greatest need was for positions of third-order accuracy.

Field of Electronic Research Should Be Opened

Of the 57 million square miles of the earth's surface, great areas are still unmapped and adequate reconnaissance maps cannot be prepared because we do not have geographic positions, not to an accuracy of 2 or 3 meters, but to 200 or 300 meters. I strongly feel that we should apply this new technique first to reconnaissance work, and refinements will be evolved and greater accuracy will result. It seems to me that we lacked something in our experimental research work in an effort to cope with this problem. Here in the United States today we have a wonderful net of first- and second-order triangulation. Between these arcs are still greater gaps where we need third-order control for topographic mapping.

This year the U. S. Geological Survey has embarked on one of the largest topographic mapping programs in its history in the United States and Alaska. Our major problem is to establish, rapidly and accurately, enough control required for topographic mapping. Costs are increasing rapidly with the use of ground parties. It seems to me that possibly because of military restrictions, or classification of material, we in the civil agencies of the government have not been brought into this field of experimental and research work which could have been of direct benefit not only to the military service but also to all other federal mapping agencies. Bureaus such as the Geological Survey, which has been doing control for mapping for 65 years, as well as other organizations in the country which are interested in determining second- and third-order positions for mapping, are vitally interested in this problem. The commercial mapping organizations in this country that make a living by conducting surveys are interested in cheaper methods of determining second- and third-order control. Given an opportunity, I believe these organizations would certainly, if it was demonstrated that they could make money at the business, devote time and effort to electronic research. All of us recognize that we have obtained a wealth of information from the practical results of work carried on by our commercial mapping organizations. They contributed directly to our surveying and mapping activities during the war. Why is it not now possible to declassify the full information regarding military development of electronics and make it available to the organizations in this country that are vitally concerned with this development?

Frankly, I have been much disappointed with the results that we might have expected from the Air Forces in their use of Shoran for mapping during the last 3 or 4 years. There are admittedly a lot of problems that I do not understand in connection with this research program, but I am confident that the more people who can be brought into it and who are interested in this new field, the better results we will obtain for the benefit of all. The American Society of Photogrammetry has been interested in this problem for a long time. We believe that the use of Shoran combined with aerial photographic mapping has great promise. The use of a gyro-stabilized mount to determine plumb points simultaneously with the location of the plane in the air from Radar stations, the possible use of the helicopter in conjunction with the same problem—all of these things require con-

tinued experimental work and research. I should like to say again I am firmly convinced that if more of us, that is, the organizations and individuals who are interested in this problem, are brought into this field, the sooner we will obtain the results so earnestly desired.

The American Society of Photogrammetry plans at a forthcoming meeting to review again the progress of Shoran and mapping. We hope to discuss experimental work already done, and the proposed programs in as much detail as security regulations will permit. Frankly I do not know how much of the entire program is still classified or how much we will hear of the experimental work that has been carried on up to the present time. I hope, however, that the War Department will see fit to invite us to participate in one of the most promising research problems that applies to surveying, mapping, and photogrammetry.

* * *

Swollen Engineering Schools

READERS of this Journal undoubtedly have been impressed with the fact that there are record-breaking enrollments in all of our engineering schools, and that perhaps a third of the total are in the civil engineering departments. Of course, the majority of these students are veterans, and most of them are in college largely because of the educational aid features of the G–I Bill of Rights. But why do so many of these young men choose engineering as their life work? Is it simply due to the wartime prestige of all technical endeavor or are there more fundamental reasons?

Engineering curricula with their emphasis on mathematics and other exact sciences are not easy. Nor can the hope of large future financial rewards be a prime consideration in the choice of this profession, for the civil engineer earns only an average income.

It is probable that there is a certain glamor about civil engineering; our big projects inspire the would-be engineer and stimulate his imagination. But it is also certain that many of these students are convinced that an engineering career offers something really worthwhile, that in sanitation, highway work, water supply, irrigation, flood control, municipal service, or bridge and dam building there is ample scope for his best efforts in the public service. Those who have practiced in the field of civil engineering and construction know that there has been a basis for such conviction in the past. They will likewise want these young men to find justification for it in the future.

The best insurance for such a happy outcome is to have jobs waiting for those students who make the scholastic grade to graduation. There will be more graduates. There must, therefore, be more jobs, not only in booming times but continuously. It is not too soon for the profession to start thinking and planning for the future of these young men.—Editorial in *Engineering News-Record*, January 23, 1947.

Shoran Investigations for Triangulation

By C. I. ASLAKSON

COLONEL, 311TH RECONNAISSANCE WING, U. S. ARMY AIR FORCES

IT HAS long been a dream of geodesists to discover a method of mapping accurately with respect to each other, widely separated points on the earth's surface when the conventional method of ground triangulation could not be employed. For many years it has been known that this problem might be solved by the use of electronic methods, but the great expense of such research prohibited its development during peacetime. Consequently when Shoran, a precise blind-bombing instrument, was developed during the war, we immediately saw the possibility of making our dream come true and adapting it to geodetic surveying.

As a bombing instrument Shoran had an accuracy of plus or minus 50 to 100 feet. That was far from the accuracy required for geodetic measurements. We decided, therefore, first to investigate the electronic design and attempt to gain additional precision by redesign and calibration. Second, we would attempt to eliminate errors by applying all the principles of error elimination used in geodetic surveying—that is, by multiple observations properly distributed over the range of error source, the principle of reversal, and the use of Least Squares solutions.

That is what we have done and our results have surprised even ourselves. Furthermore we have only scratched the surface. I predict without hesitation that we shall in the near future be able to make first-order triangulation surveys over lines 200 to 500 miles in length, making the distance measurements by electronic means.

Description of Equipment

First, let me give a brief description of the instrument. The Shoran equipment consists of three main units—an airborne transmitter-receiver and two ground station transponders. The airborne station transmits extremely short pulses alternately at 1/20-second intervals to the ground stations, a different frequency being used for each. The ground stations receive and retransmit the signals to the airborne station on a third frequency which is common to both. At the airborne station the returned signals are presented on the cathode ray oscilloscope as "pips" or "bumps," together with the outgoing signal. The design of the instrument is such that when the three pips—that is, the return signal pips and the outgoing signal pip—are aligned, two dials read the two distances in statute miles to the ground stations. Since we are interested in the surveying adaptation I shall not go further into detail in describing the equipment other than to say it is quite portable and quickly installed.

Procedure

From the above it can be seen that an airplane can be positioned in the air by means of two simultaneous distances to known points and the known heights of plane and ground stations. In surveying we perform the opposite of this operation. From two known Shoran distances and known heights, the distance between the two ground stations is determined. The accuracy of that distance is depend-

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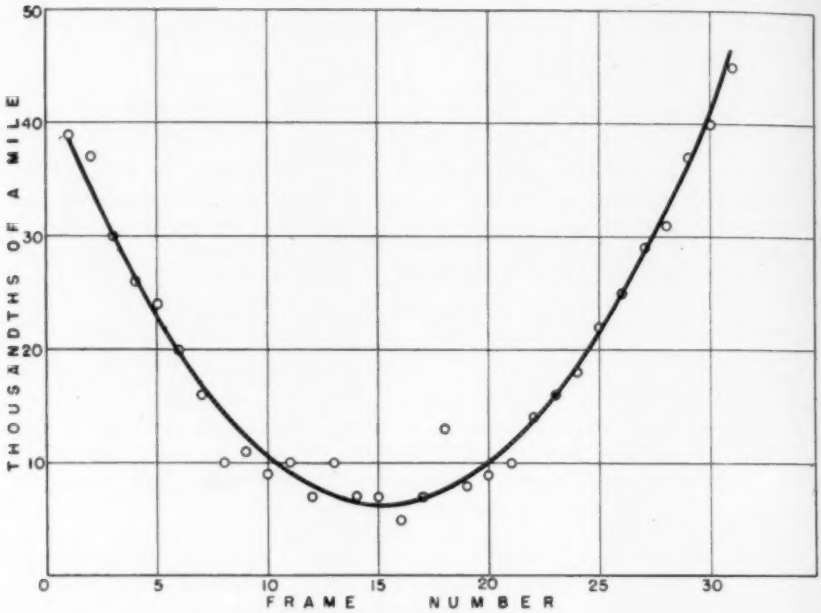

FIGURE 1.—Shoran line crossing minimum distance curve, Cheyenne-La Junta, May 1, 1946.

ent on two single, simultaneous readings on the distance dials. Now for geodetic operations an improved procedure is used. We cannot rely on a single pair of readings. Therefore we determine the minimum sum of a large number of pairs of readings as we *fly across the line between two ground stations.* In order to obtain these readings we employ a photographic recorder which records, at 2- to 3-second intervals on 35 mm film, the data required to make the computations and reduce to geodetic distance. These data are the readings of the Shoran mileage counters, the barometric altimeter, air temperature indicator, clock, fluxgate compass, frame counter, and data card. The equation of the relationship between the frame interval (or ground distance normal to the line) and the sum distance can be shown to be a hyperbola. In practice we substitute a parabola to simplify the computation. Our computation then consists of the Least Squares solution of the minimum ordinate (or sum distance) of the parabola. (*See* fig. 1.) By always using a fixed number of frames certain coefficients may be precomputed to assist in quickly determining the parabolic coefficients.

ACCURACY

It is apparent then that the accuracy of the final result depends on four basic factors:

1. The accuracy of the measured time interval between the sending and receiving of the signal pulses.
2. The knowledge of the propagation velocity along the path of travel of the signals.

3. The relationship between the curved or refracted propagation path and the geodetic distance between the two stations.

4. Knowledge of the height of the airborne instrument.

These relationships indicated that the research should follow along the following four lines: (1) instrumental modification and calibration, (2) determination of a velocity correction, (3) determination of a geometrical correction, and (4) determination of height of airplane. These are the lines we followed, but there is insufficient time in a talk of this length to describe the enormous problems involved and the methods of attack. We feel that we have gone a long way toward their solution.

Results

The results of the adjusted Shoran triangulation conducted by the 311th Reconnaissance Wing in Colorado, Kansas, Nebraska, and Wyoming are well within the accuracy required of first-order triangulation. After adjustment the worst discrepancy remaining in the comparison of the inverse geodetic distances based on the first-order triangulation of the U. S. Coast and Geodetic Survey and the adjusted Shoran distances was less than 12 feet (0.0022 mile). The worst ratio of accuracy was 1 part in 113,350. A new method of line crossing computation is now being investigated and may reduce these discrepancies still further.

The complete results are shown in Table 1.

Table 1.—*Results of Shoran accuracy tests*

Geodetic line	Shoran distance	Inverse distance	Difference		Adjusted Shoran	Difference	
			Miles	*Feet*		*Miles*	*Feet*
La Junta–Garden City	148.5341	148.5395	−0.0054	−29	148.5384	−0.0011	−6
Cheyenne–Imperial	173.7457	173.7471	−0.0014	−7	173.7459	−0.0012	−6
Imperial–Garden City	181.3697	181.3694	−0.0003	−2	181.3678	−0.0016	−8
La Junta–Imperial	198.7193	198.7099	+0.0094	+50	198.7114	+0.0015	+8
Cheyenne–La Junta	227.2899	227.2868	+0.0031	+16	227.2855	−0.0013	−7
Cheyenne–Garden City	308.5241	308.5252	−0.0011	−6	308.5274	+0.0022	+12

It must be remembered that the positions of the Coast and Geodetic Survey triangulation stations have an uncertainty of at least as much as these final differences.

It must be stressed that the above results were accomplished not with a surveying instrument designed for accurate electronic distance measurements but with a modified bombing instrument. A new instrument designed particularly for geodetic surveying will eventually be developed.

There are vast areas on the earth's surface, such as the island chains, where the distances involved prevents their accurate linking together by any other means. The future of electronic geodesy is wide open and we have an excellent start, but it is still only the beginning. Unquestionably during the next few years we will see developments in electronic surveying which will revolutionize existing methods.

Shoran in Hydrographic Surveying

By LIEUT. COMDR. C. A. BURMISTER
CHIEF, RADIO-SONIC LABORATORY, U. S. COAST AND GEODETIC SURVEY

IT IS OBVIOUS that the remarkable wartime developments in electronics are resulting in major changes in some of our surveying and mapping methods and no doubt will render some of them obsolete. While the ultimate uses of these devices can be only partially estimated at present, they are certain to bring about a definite improvement in the quality of our surveys, as well as a decided acceleration in their rate of performance.

You have heard how Shoran—SHOrt RAnge Navigation—can be used in geodetic surveys. Another class of work which will receive major benefits from this new electronic device is hydrographic surveying. In war, Shoran made it possible for a bomber to determine distances rapidly and accurately from known positions on the ground and thereby to plot its course unerringly to any target designated for destruction. In peace, with substantially the same equipment, it is possible for a hydrographic surveying ship to determine distances from two or more known positions either on shore or afloat, and thereby to plot positions rapidly and accurately as it proceeds along a sounding line.

Nature of the Problem

Greatly oversimplified, the process of mapping or charting may be described as consisting of two problems: "What it is" and "Where it is." The "what" in mapping, is obviously, a mountain, house, highway, or the ground elevation. The corresponding "what" in nautical charting is generally the depth below the water surface. The determination of the "where" is by a system of measurements of one kind or another from basic control points. Over the sea, the position determination, or fixing of the sounding, is done by a process analogous to triangulation using basic control points ashore. The actual plotting of points is usually a graphic process. When within visible distance of points, horizontal sextant angles have been used for the protractor-solution of the well-known "three-point problem."

RAR Method of Hydrographic Control

Years ago, to extend our range beyond sight of shore points and to permit work during darkness or fog, a method of indirect distance measurement at sea was developed which utilized underwater sound transmission and radio. This system became known as Radio Acoustic Ranging, or RAR. Briefly, it consists of the following procedure: A bomb is thrown from the moving survey vessel. Its explosion, which is recorded instantly on a chronograph aboard the vessel, causes sound waves to register on a hydrophone attached to a sono-radio buoy established in a predetermined position. The buoy receives the sound impulse and automatically returns a radio signal to the ship. We know the velocity of sound in sea water. We have a chronograph measure of the elapsed time between

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the bomb explosion and return of the radio signal from the buoy. We can now compute the distance.

While RAR has been used effectively for many years in controlling offshore surveys, it has certain inherent weaknesses and limitations. The very nature of the sound wave, which may travel in an almost unlimited number of paths, causes reflections and refractions due to varying temperature and irregular configuration of the ocean bottom, which interfere with its transmission. Another objection is that it is necessary to know the temperature and salinity of the water to determine sound velocity, necessitating repeated observations over the water area to be surveyed.

Shoran Method of Hydrographic Control

Shoran constitutes no new principle in hydrographic surveying but it does apply a new and more effective method for the determination of distances from known control points. Shoran does the job more quickly, more accurately, and more simply, under conditions of atmosphere and sea which will not permit the use of Radio Acoustic Ranging.

Shoran is based on the fact that radio waves travel through the atmosphere at a very nearly constant velocity of approximately 186,000 statute miles per second. Success of the method is due to the accomplishment of electronic engineers in devising means for accurate measurement of the remarkably small time intervals involved in the travel of radio waves to a target and back. In the familiar Radar, dependence is placed upon the reflection of radio waves from natural objects encountered. Shoran strengthens and specializes this principle by use of responding radio stations set up at known points, which return intensified signals from the specific positions of the responding stations. (*See* fig. 1.)

Similarity to RAR

There are certain similarities between Shoran and RAR. An installation called an *interrogator,* on the vessel, takes the place of the bomb used in RAR. The interrogator sends out radio impulses to (or interrogates) a *transponder,* or *ground station,* which corresponds to the sono-radio buoy. The ground station returns the impulse to the interrogator, in much the same way that the sono-radio buoy receives the sound waves and returns a radio signal to the vessel. As in the case of the RAR buoy, the position of the ground station must be determined in advance. Since a known distance from the ground station would give only a "line of position" for the ship, two or more ground stations are established, and the distances are measured simultaneously by the ship equipment.

Instrumental Equipment

The instruments are very compact and light in weight, a necessary consideration since they were designed for use on airplanes.

The interrogator is the heart of the Shoran equipment. It contains a transmitter and a receiver-indicator unit.

The transmitter is designed to transmit on two frequencies. It initiates the interrogations to the ground stations, sending them out on the frequencies to which the ground stations are tuned. The signals are actually very high frequency pulses of extremely brief duration, there being 930 pulses per second.

The receiver-indicator receives and separates the replies from the two ground

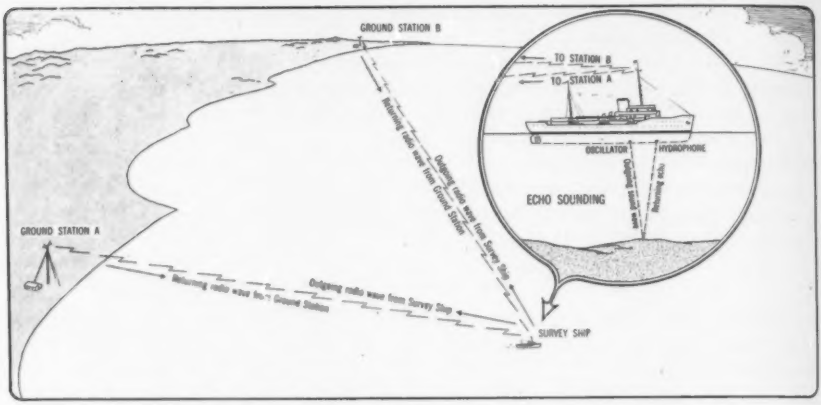

FIGURE 1.—ECHO SOUNDING AND ELECTRONIC POSITION DETERMINATION

While the ship's fathometer measures the depths under the vessel by sound, the position of the vessel is determined by electronic methods. The interval elapsed between the outgoing and returning radio signals is measured on the survey ship and the distance determined to the known ground stations.

stations and measures very accurately the time elapsed between the outgoing impulses from the transmitter and the return impulses from the ground stations.

This measurement of time intervals between radio impulses is the fundamental function of Shoran. It is done by means of a cathode ray tube wherein a stream of electrons is manipulated with a speed and facility so remarkable that time intervals of hundred millionths of a second are registered by "pips" on the fluorescent screen of the tube at a scale permitting easy measurement. A circuit called a Variable Calibrated Phase Advance is manipulated to remove instrumental lags and constants, and the operator reads true distance from the vernier. The trace shown on the fluorescent screen of the indicator tube is circular with a reference pip at the top, and the two distance pips showing somewhere else. In making the distance measurement, the two distance pips are aligned with the marker pip. When operating on the 1-mile scale, this sweep makes 93,109 "revolutions" per second, corresponding exactly to 1 statute mile per revolution. The sweep length, with a diameter of about 2 inches, is approximately 6 inches. It is a simple matter of using the verniers attached to the calibrated phase advance circuits to divide this 6-inch sweep into hundredths or even thousandths of a mile.

The transponder on shore is a self-contained unit designed to adjust itself to the ship station in all the various timing and control elements necessary to receive and return the radio waves.

Figure 2 shows the mast and antenna system for the ground station. The mast is about 50 feet high and consists of six sections of telescoping tubing made of plywood. Several sets of guys support the mast so that it is strong enough to withstand as much as a 100-mile-an-hour wind.

Power for the ground station is supplied by a small gasoline-driven generator set.

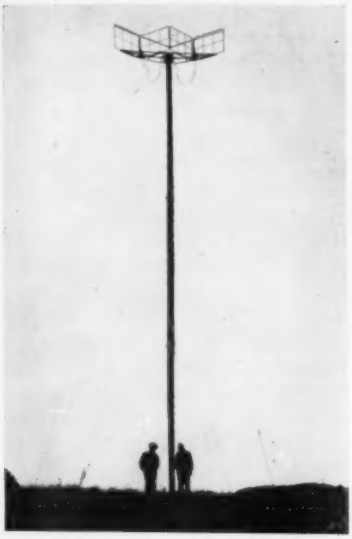

FIGURE 2.—Mast and antenna system for Shoran ground station.

SHORAN INVESTIGATIONS IN ALASKA

The first experimental work on Shoran for hydrographic surveying was carried out in the Aleutian Islands in the summer of 1945 by the Coast and Geodetic Survey Ship *Explorer*. (*See* fig. 3.)

Station SHOR was established on the easternmost of the Semichi Islands, during two working days, at a ground elevation of 220 feet, making the antenna height 270 feet. Station RAN was established on Attu Island on a low knoll 105 feet in elevation, making the antenna height 155 feet. Work on this was completed in about 10 hours. After triangulation locations of these two stations, their distance apart was computed as 41.382 statute miles.

Preliminary Tests

Test runs were made to check the operation of the stations and the distance measurements. Having determined the correct vernier setting for station SHOR, with some accuracy, the factor of error of distance

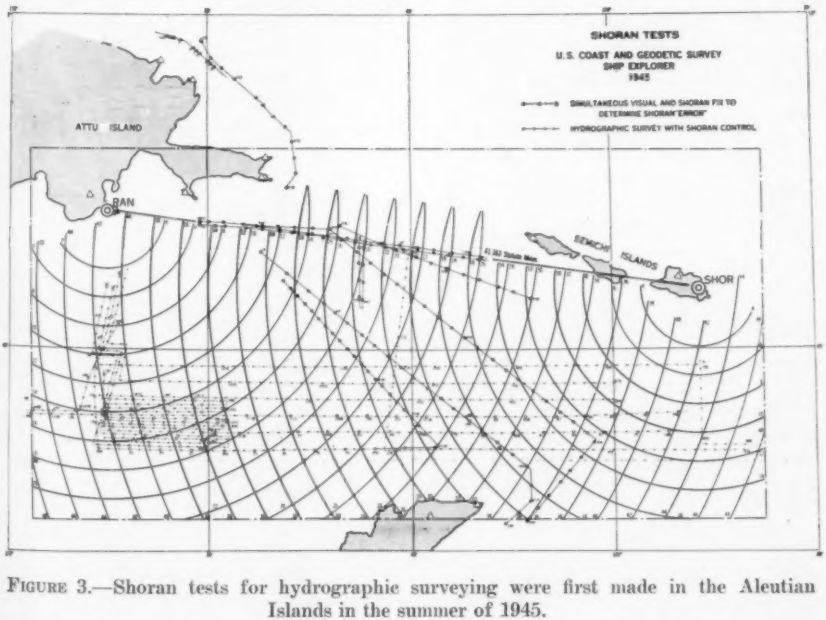

FIGURE 3.—Shoran tests for hydrographic surveying were first made in the Aleutian Islands in the summer of 1945.

readings from RAN, with the same setting, was determined. This was accomplished by running along the base line, taking simultaneous readings of the two distances at short intervals, holding the ship on the proper course by running ranges or by control with sextant fixes. The line was run on two different days with comparable results. They showed that the two ground stations did not react alike, and the indications were plus 0.002 mile to SHOR and plus 0.016 mile to RAN. During the operational tests about 750 comparisons were available between the Shoran distances and the scaled distances from station SHOR and about 500 from Station RAN. Even with this large number of comparisons, the errors cannot be considered to have been completely eliminated. In the first place, the absolute length of the base line is not known, since it was determined through several related schemes of second-order unadjusted triangulation. The computed length was 41.382 statute miles as against the uncorrected Shoran length of 41.363 miles, a difference of about 100 feet. Some of this difference must be expected to be in the computed length. Secondly, the same weight has been given to a sextant fix as to triangulation, whereas an error of 1 minute in a sextant angle can give a position error of from 12 to 75 feet, depending upon the size of the angle and the distance from the signals. Probably the larger part of the error is in the Shoran measurement, though the magnitude is not definitely proved by these tests.

Hydrographic Surveys

Actual hydrographic surveys were conducted for about 4½ days, during which somewhat more than 400 statute miles of sounding lines were run. During 2 of these days runs were made to determine the maximum distance over which return signals were useful; that is, where they became too weak to give good returns. The results of these runs were highly satisfactory, distances over 47 miles being read with ease. Both stations gave about equal range, though there was a difference of 120 feet in their antenna elevations. The indications are that the Shoran range is nearly twice the line of sight distance as calculated for ship and ground station antenna heights, up to 270 feet elevation.

A portion of the hydrographic survey includes a small area of close development where the lines were spaced at about 350 yards. Control of the ship was perfect at all times. This spacing of 350 yards could be materially reduced where necessary for closer development.

Systematic and Random Errors

As with any device which measures distances, directly or indirectly, there are certain errors which are always present in Shoran. These are generally classified as systematic and random errors. The systematic errors are of two kinds: (1) that due to the difference between the Shoran distance and the map distance, and (2) that due to variations of velocity of the radio waves due to changes in barometric pressure and so on. The first is caused by the difference in elevation between the ship and ground station antennas; this causes the Shoran distance to be somewhat longer than the great circle distance between the two points referred to sea level, or the map distance. The Shoran path can be very closely approximated by a circular arc with a radius of about 15,000 statute miles (or more closely as 3.91 times the radius of the earth). For the purposes of hydrographic survey control, the elevations of the ground stations will be relatively small—generally about 500 feet as a maximum—and the ship antenna

will be of the order of 100 feet, so that the combined systematic errors will not exceed 0.015 statute mile, or about 25 yards.

The random errors may be classified as follows: personal errors in reading and setting the verniers; non-linearity of the calibrated phase advance circuits; the inability to standardize the ground station exactly to its predetermined value. These random errors will, if all accumulative, amount to as much as 0.10 statute mile, or 16 or 17 yards; and so will cause a position uncertainty dependent upon the angle with which the distance arcs intersect.

Advantages of Shoran

This short period of experimentation with Shoran indicated that it is an ideal system for the control of hydrographic surveys. Shoran ground stations can be located accurately by triangulation; two or three stations will control a large area, and the survey will be completely homogeneous. The total margin of systematic and random errors is small—considerably smaller than those encountered in RAR—and well within the accuracy requirements for offshore surveys. The potential accuracy of the system is such that any distance can be measured with a probable error of not more than 5 yards, regardless of the length of the line, up to the limiting range of the equipment. Positions as determined by the intersections of two simultaneous distance arcs will have an accuracy better than 15 yards in the area where the angle of arc intersection is greater than 30 and less than 150 degrees. Once the correct settings are determined for each set of equipment, it is probable that an accuracy of about 1:10,000 can be secured—thus raising the position fixing afloat from fourth-order to third-order accuracy.

The range of the system is such that very accurate surveys can be made in areas as far offshore as 40 to 50 miles. Three stations on more or less a straight line and separated by 35 to 40 miles will control an area about 100 miles long by some 45 miles in width along one side of the base line.

The rapidity with which the Shoran fix can be taken and plotted make development of critical areas very simple, and it should be very easy to run closely spaced lines and "splits" wherever necessary. Actually, fixes can be taken at any interval desired with a possible minimum of 30 seconds. In the system developed, the time required to take and plot a Shoran fix was about 15 seconds from the time of "mark" to the time the position was plotted. This is in sharp contrast to the time necessary to plot a sextant fix, sometimes as much as 90 seconds. Small changes in course are immediately apparent to the navigator, for the Shoran position is actually more accurate and consistent than sextant fixes—the entire area is controlled by one set of stations or signals, a condition which is never met with in any visual control system.

Another advantage of the Shoran method is its flexibility. It can be applied to the measurement of base lines at sea, thus permitting the establishment of precisely fixed floating responder stations where circumstances require. A station can be easily installed on a ship. This would be advantageous in carrying control into an area far outside that available from land stations. The velocity of radio waves through free space is almost constant under any of the conditions likely to be met with during hydrographic surveys. Therefore the sum of two Shoran distances measured along a base line will be the length of that line. Or, if it is not possible to run along the base line, the ship can make several crossings

at very slow speed, at the same time taking Shoran fixes at even time intervals, from which the length can be deduced by a method of least squares. By development of this process, preliminary triangulation can be carried by Shoran far in advance of the regular triangulation. Shoran would also be valuable in supplementing triangulation where the lines are very long, and the angles small; or where fog, haze, or smoke interfere with seeing over long periods of time.

The effectiveness of the system is in no way impaired by darkness, fog, or rain. Static is scarcely noticeable; even the effect of high powered radio equipment is negligible.

Conclusion

The tests in Alaska proved that Shoran can be easily adapted to the control of hydrographic surveys. The system is rapid and economical, and the limits of accuracy are well within the requirements for offshore control. The errors inherent in Shoran are lesser and more easily determined than in the old method of Radio Acoustic Ranging.

The successful application of Shoran to hydrographic surveying opens up a new field of electronic techniques which promises to increase our range, facility, and accuracy.

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Ocean Oil-Well Problems

Drilling for oil in the ocean bed 10 miles from the coast presents special problems, the American Society of Mechanical Engineers was told in Tulsa, Okla., by R. G. Watts of the Magnolia Petroleum Company. He described special design features used in a recent drilling.

This company has just drilled a 12,874-foot hole in the Gulf of Mexico 10 miles from the Louisiana coast, the first operation of this nature so far from land, he stated. No production was obtained, but what oil men call "drilling directionally" from a whipstock set at about 10,500 feet is now under way. It is lateral drilling, or sidewise drilling, from the original hole.

Off-shore drilling is nothing new. Many producing wells are found in the waters off California, Louisiana, Venezuela, and other coasts. Drilling 10 miles at sea requires new techniques, but similar methods will soon be used in drilling two other wells, one 20 miles and the other 29 miles from the Louisiana shore.

The depth of the Gulf where this "10-mile" well is drilled is 16 feet at low tide. A platform was erected on piles during the past summer at an elevation of 20 feet above mean high water to give protection against high waves. The platform had to be larger than for near-shore drilling because greater space was needed for the storage of drilling equipment, mud, fuel oil, fresh water, and standby units. The platform structure was built to withstand a pressure of about 800 pounds per square foot of exposed surface.

Experience gained in drilling this far off-shore well will be valuable in other cases where the ocean bed will be explored for oil in rough Atlantic waters and elsewhere. Geologists predict that petroleum will be found in the Continental Shelf which projects many miles under the ocean from the southeastern coast of the United States. Underwater explorations are now being made near the Bahama islands some 150 miles from Florida by scientists in diving-bells mothered by surface vessels. They are using so-called gravity and other instruments to determine if probable oil-bearing strata exist below. The final test, however, must be made by drilling.—*Science News Letter*, March 15, 1947.

Engineering Surveys in Highway Planning and Construction

By R. GETTY BROWNING*

Planning of State Highways

A MAP showing the result of a traffic study in my home state of North Carolina, might, at first glance, appear as some sort of a Chinese puzzle, but in reality it shows the direction and volume of the several streams of traffic that pass through this State. An analysis of a map of this sort will usually indicate the most logical location of any highway that may be projected to connect two or more cities. Assuming also that an adequate study has been made of all the cities that will be affected by the proposed highway improvement, an analysis of each one will indicate pretty clearly where the new highway route should enter and leave the cities to be connected, and whether or not it would be advisable to by-pass any intermediate village or town. The careful preliminary planning of a highway system is of vital importance because roads once built are most difficult to change. Every effort should be made to see to it that they are located correctly in the beginning.

Careful planning and the thorough analysis of traffic surveys are an essential part of this preliminary study and without this background it is doubtful if any road can be located with much assurance that it will be possible to co-ordinate it with other sections of the system which may later come up for construction. Predicated on properly made traffic studies, a master plan could be developed for the entire state, and on this plan could be indicated, at least in a general way, the importance of the various highways, both from the standpoint of cost and priority of construction. This method of approach might prevent many of the unfortunate mistakes, the evidence of which we see all too frequently. It is true, of course, that when modern roadbuilding was in its infancy, few people fully realized the magnitude of the undertaking which they faced in establishing new routes of travel or in selecting certain sections of road for improvement. Naturally a great many mistakes were made, but there is far less excuse to repeat these mistakes today, since we have so much more information concerning the requirements of modern highways and so many improved methods of securing and utilizing the factual information so vital to correct location and design. Certainly we should take advantage of all the most modern means which now are available in the preliminary, as well as in the final, planning of our highway systems.

Preliminary and Location Surveys, Maps, and Field Notes

Assuming that a certain section of highway is to be improved, the first requirement is to establish the proper geometric standards to govern the survey and design. These standards, will, of course, be determined only after a thorough

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study of the importance of the road, the traffic that it is expected to carry, the speed which is to be allowed, and the terrain through which the road passes. With these data the locating engineer usually would make a preliminary survey along a route which has been selected from a study of the topographic, aerial, and other maps of the area, supplemented by personal contact with the terrain. The preliminary survey would establish secondary controls along the route which later would be connected by suitable surveys to determine the feasibility and cost of fulfilling the geometric specifications which had previously been adopted for the survey. Many times, at this point, the terrain is found to be so broken that the question arises whether more money should be spent on grading the project rather than to lower the standards of alignment and sight distance, or whether to increase the gradient.

Possibly there is no rational method of determining how much we might rightfully spend on the grading of a project without being considered extravagant, but I think it is obvious that in too many instances highway engineers have failed to spend enough on the grading to insure a permanent roadbed—the result being that as the road grew in importance and speeds increased, it was found necessary to remodel or relocate many miles of such roads to bring them even reasonably close to the standards demanded by the traffic of today. As a suggestion, I submit that an approximate method of deciding how much we might be justified in spending for the grading of a given highway would be to balance the cost of earthwork against the combined cost of the paving and drainage structures.

If the grading is done correctly in the beginning, later improvements in the highway, such as widening and replacing of worn-out pavements, etc., can be handled with much less expense than if the grade, as well as the pavement, must be radically changed.

Acquisition of Right of Way

At the proper time either before the project is definitely located or directly afterwards, the right-of-way negotiations should be carried through to a conclusion. The width of right of way should be in accordance with the importance of the highway, but a generous width should be provided at important intersections, where large structures are to be constructed or "clover leaves" developed; and care should be taken that no conflict exists between the projected highway and any previously constructed utility such as a canal, railroad, dam, or manufacturing plant.

Most of the states have developed methods of their own for handling the acquisition of right of way. Some states buy the land outright in fee simple, while others simply take an easement on the land with the understanding that the fee does not pass, and that the land involved shall revert to the property owner if the road should be abandoned as a public highway.

It might be of interest to briefly sketch the method used in North Carolina, as we think it is a rather practical and economical way of dealing with this important matter. When the Highway Commission was organized many years ago, it was authorized by the Legislature to acquire rights of way under the provisions of a law which reads, in part, as follows:

"The State Highway and Public Works Commission is vested with the power to acquire such rights of way and title to such land . . . as it may deem necessary and

suitable for road construction, maintenance, and repair . . . either by purchase, donation or condemnation in the manner hereinafter set out."

In actual practice it has proved to be quite simple to operate under this law. The survey having been made and the right-of-way width determined, the various property owners are contacted; and in their anxiety to have access to a modern highway, many of them sign up without cost, while others stipulate certain damages such as the rebuilding of fences, the changing of ditches, the provision of access to water, the moving of buildings, and payment for growing crops, etc. In North Carolina we simply take an easement on the property, for highway purposes only, and so far our experience has been that the people of the State are not antagonistic to this method.

Payments in connection with right of way are handled with very little confusion or red tape. An adjuster contacts the property owner and if a mutually agreeable settlement can be arrived at, he makes a report which, when approved by the Legal Department, is passed on to the Auditor for payment. The check is then presented to the owner upon the signing of a receipt by him. The whole procedure is quickly handled and with a minimum of bickering, and quite seldom do any of these cases go to court.

Another method which has been utilized by the State of North Carolina in acquiring rights of way was developed in connection with the Blue Ridge Parkway. Under the provisions of a certain section of the highway law, a map, showing the right of way desired, the property lines, and names of property owners, is posted at the courthouse in the county in which the land is located. A statement on the map provides that all the property owners are thereby given legal notice that the State has taken over the property indicated on the map, that from that time the title vests in the State, and that the State will entertain a claim for compensation from the rightful owners. This method obviated the necessity for tracing innumerable titles and making hundreds of hopelessly complicated property surveys in rough mountainous country. This procedure simply meant that the State found it necessary to take a certain number of acres from a man's holdings no matter what his total acreage might be. Therefore, the State was concerned primarily with determining only that area contained within the boundary lines shown on the map, and I can say that this plan has worked exceedingly well in dealing with people whom one might well expect to be suspicious and troublesome to handle.

Use of Geometric Control and Coordinate Systems

Generally speaking, I feel that the use of State Cooordinate Systems would be of great value to roadbuilders, power companies, real estate companies, and consulting engineers engaged in any sort of development work. Certainly all map work throughout the state could be more accurately done if controlled by such a system; and no doubt, if proper regulations were set up to insure that it would be used, the over-all result would be beneficial.

In 1932 the State of North Carolina appropriated $27,500 to carry on control surveys under a co-operative arrangement with the Federal Government, the latter contributing $82,500 to the program. Many monuments accurately tied in to the federal network of triangulation were established, but little use if any, has been made of them. The very people who would receive the greatest benefit from such a system, unfortunately, are the least able to avail themselves of it. I refer

to the average landowner. In the original colonial states, of whic North Carolina is one, individual property holdings were, in the first place, selected by choice from open State-owned land. The boundaries of such tracts were indicated by the owner, and many times they were quite irregular in outline and very poorly surveyed. Many of the old surveys were made by the use of magnetic bearings and surface measurements, and a great many were closed by the simple formula of stating, at the beginning of the last line, "and thence by a straight line to the beginning." These surveys could not possibly "close," and as the notes were seldom checked in the field, many errors of measurement and in the bearings were made but never found until later surveys disclosed them. The description of the boundaries of such tracts were often inconsistent, ambiguous, and downright silly; and yet many were carried from one deed to another and may now constitute the only record we have in our local land office. In too many instances the land records are kept by an official who knows nothing whatever of surveying. He simply records the documents presented to him.

It is probably true that if we were to set up a State Coordinate System, it would be a tremendous undertaking to reconcile the various property lines to it, although I think it might be done if an efficient method of controlling land surveys were put into effect. For instance, if a capable surveyor were elected or appointed to take charge of land records in a given county, and if the state provided a manual of instructions for land surveyors and required that they follow it under pain of losing their license to practice, provision could be made to insure a satisfactory degree of accuracy in the work. The data to be submitted for recording could be specified, and the computation sheets from which he determined his error of closure and the distribution of this error, should accompany the map. He should also include a description giving the corrected bearings and distances determined after balancing his surveys. The county surveyor could then readily check the whole procedure and determine whether or not it complied with the manual of instructions before passing it on to be recorded. Surely we gain nothing by filling the records with inaccurate information.

If such a system were set up it seems that in the course of time the whole network of property lines, highways, power lines, railroads, canals, streams, and other features of the terrain might be tied into a State Coordinate System which then would be of the utmost value to the state and to the engineering profession.

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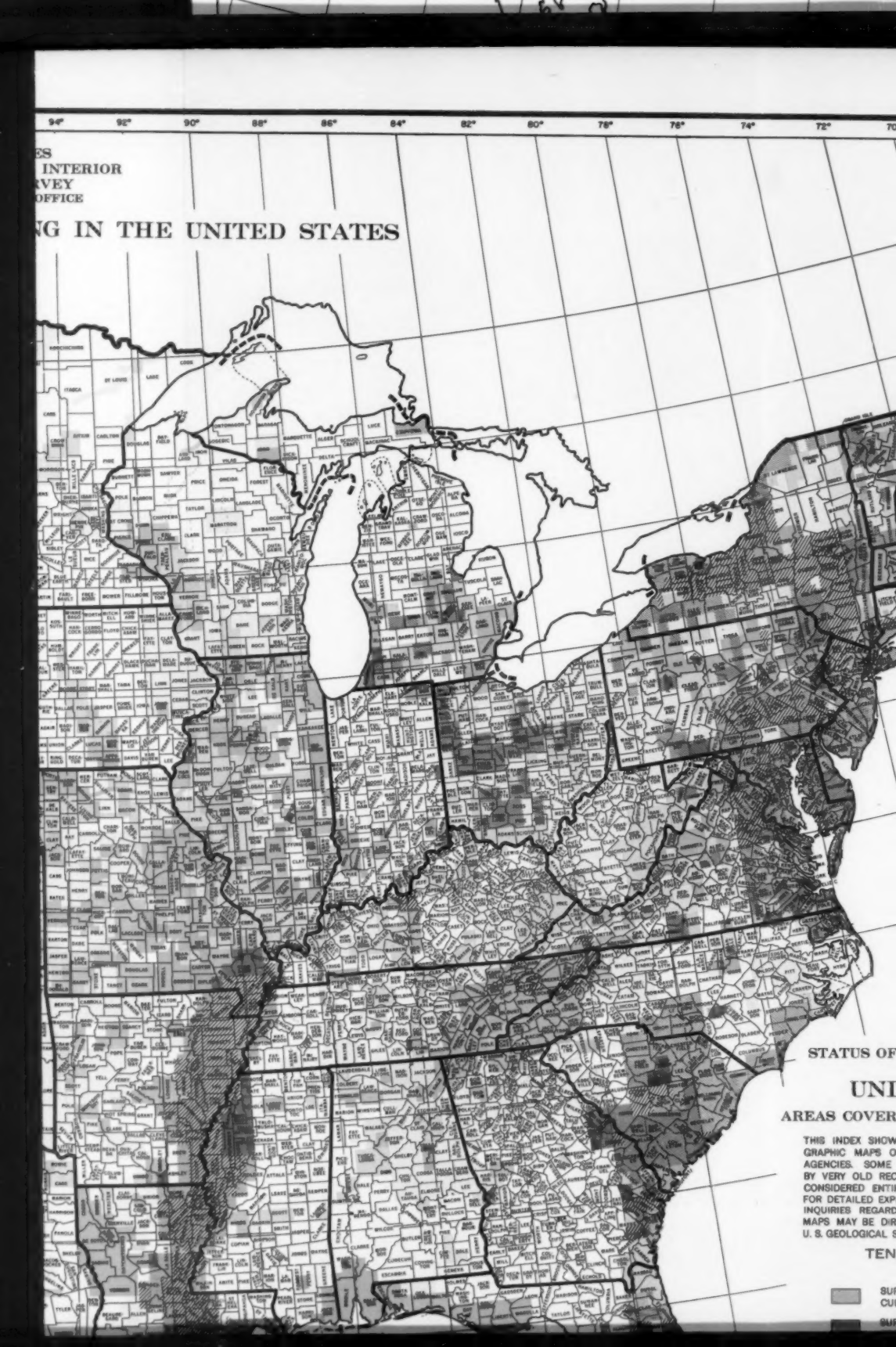
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MAP INFORMATION OFFICE

STATUS OF TOPOGRAPHIC MAPPING IN THE UN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AREAS COVERED BY TOPOGRAPHIC MAPS

THIS INDEX SHOWS AREAS COVERED BY PUBLISHED TOPOGRAPHIC MAPS OF THE GEOLOGICAL SURVEY AND OTHER AGENCIES. SOME ADDITIONAL AREAS HAVE BEEN COVERED BY VERY OLD RECONNAISSANCE SURVEYS WHICH ARE NOW CONSIDERED ENTIRELY INADEQUATE FOR PRESENT DAY USE. FOR DETAILED EXPLANATION, REFER TO ACCOMPANYING TEXT. INQUIRIES REGARDING THE AVAILABILITY OF TOPOGRAPHIC MAPS MAY BE DIRECTED TO THE MAP INFORMATION OFFICE, U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.

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88°
86°
84°
82°
80°
78°

STATUS OF TOPOGRAPHIC MAPPING
IN THE
UNITED STATES

AS COVERED BY TOPOGRAPHIC MAPS

HIS INDEX SHOWS AREAS COVERED BY PUBLISHED TOPO-RAPHIC MAPS OF THE GEOLOGICAL SURVEY AND OTHER GENCIES. SOME ADDITIONAL AREAS HAVE BEEN COVERED Y VERY OLD RECONNAISSANCE SURVEYS WHICH ARE NOW ONSIDERED ENTIRELY INADEQUATE FOR PRESENT DAY USE. OR DETAILED EXPLANATION, REFER TO ACCOMPANYING TEXT. QUIRIES REGARDING THE AVAILABILITY OF TOPOGRAPHIC APS MAY BE DIRECTED TO THE MAP INFORMATION OFFICE, S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.

TENTATIVE APPRAISAL

GEOLOGICAL SURVEY

- SURVEYS MADE BY MODERN METHODS CULTURE REASONABLY UP-TO-DATE.
- SURVEYS MADE BY MODERN METHODS REQUIRING CULTURAL REVISION.
- OLDER SURVEYS—REQUIRING CULTURAL REVISION AND PARTIAL RESURVEY.
- SURVEYS MADE BY RECONNAISSANCE METHODS REQUIRING COMPLETE RESURVEY.
- WORK IN PROGRESS.

OTHER AGENCIES

- TOPOGRAPHIC MAPS OF STANDARD CONTENT.
- OTHER USABLE MAPS.
- WORK IN PROGRESS OR SCHEDULED FOR NEAR FUTURE.

50 0 50 100 150 200 Miles

FIRST EDITION - JAN. 1947

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The Land Surveyor's Signposts

By FORREST DANIELL
CIVIL ENGINEER, THE TEXAS COMPANY, HOUSTON, TEXAS

WHEN the street names on signposts in a large city are battered, obscured, or destroyed, the urbanite finds it an ordeal to traverse a metropolitan area in search of a desired street address. Trees—as signposts—furnish the surveyor of wooded regions the best vehicle to follow the footsteps of the original surveyor. The field notes of the original surveys—as found recorded in the Texas General Land Office and in the county surveyor's office—almost without exception show when and by whom they were surveyed, while the recorded deed or field note description of portions of the survey sometimes indicates these facts. It follows that by having the field notes of a survey which is to be retraced, one can feel confident that he is running along the original lines if ne can find surveyors' marks on trees dating back to the year in which the notes were made. However, if the surveyor should find marks of an earlier date than called for in the deed, it might indicate a survey line which has been run prior to the particular survey. Frequently, parallel lines along a survey or tract line may be observed and differentiated by the ages of the marks found on the trees.

Marking Lines Between Corners

Trees along the lines of an original or private survey are usually marked so that the lines can be more readily retraced. A tree that stands on a survey or tract line is called a line, or "fore-and-aft," tree. The nearer a line tree is to a corner being searched, the more valuable it is as an aid in such location. Such a tree may be marked in many different ways. Usually the opposite sides of a tree are marked "waist or head" high with an elliptical blaze separating two horizontal hacks. Sometimes the opposite sides of a tree are marked with three horizontal hacks spaced about 3 or 4 inches apart. Each hack is made with one clear stroke of the ax or machete from 2 to 4 inches long with the cut extending through the bark just into the live wood tissues of the tree. The blazes should be about 6 inches in height and about 3 inches in width. If the blazes are cut through the bark just into the wood tissue, the resultant scar will usually be visible, without a minute examination, as long as the tree lives.[1]

If the ax mark does not penetrate the wood tissue, but only makes a thin cut into the bark, or a knife-planed cut along the rough edges of the bark, a careful inspection of any suspected tree will be required. Sometimes the bark of the tree will have to be viewed alternately in sunshine and in shadow, and by a side as well as a frontal observation. A hack mark not readily observed may sometimes be discovered by feeling the bark for a smooth-planed surface.

As almost all trees on or near property lines have marks made by hunters, woodsmen, or construction workers, one should learn to discount marks not made by surveyors. However, an experienced surveyor makes a habit of incorporating

[1] These observations are based on surveys made in Texas. For the proper marking of trees in the states having sectionized lands, see "Manual of Instructions for the Survey of Public Lands of the United States, 1930," *U. S. Government Printing Office*, Washington 25, D. C.

in his field book record quite a number of marks on trees to which he does not attach much importance and indicates such in his field notes by a question mark. These questionable marks may be discarded or re-inspected later, depending on other evidence found along the line. A sufficient number of trees within a few feet of the line on either side should be marked so that at some later date the survey line will easily be recognized. It is essential that these marked trees be located close to the survey line because at some later date only one or a few of them may be found and used in the relocation of the line. The marking should be done by making three hacks on the side of the tree parallel to the survey line. Blazing and hacking of trees should not be made along lines known as transit, random, or temporary lines.

Witness or Bearing Trees

Because material and transportation were not available to the early surveyors, permanent monuments at survey corners were not possible. The surveyor used natural material found on the ground by raising an earthen or rock mound, planting a wooden stake, and when in the woods by suitably marking trees and referencing them by course and distance to the corner position. In cases where such markings were carefully made they served a good purpose in preserving the corners later found by subsequent surveyors. As trees, like people, come and go, there are now very few of the original bearing trees still standing; and of those remaining, few will show a well-defined and outwardly visible mark as originally made by the surveyor.

As a rule, marks in the form of crosses, hacks, and letters, made on smooth or fine barked trees properly struck, heal over by the flow of new growth so satisfactorily that they may be identified for the life of the tree. (*See* fig. 1.) Rough barked trees such as post oaks have been identified by experienced surveyors as original bearing trees where the marks were not visible on the outside of the tree. Some surveyors, anxious to prove the identity and age of marks on bearing trees, have chopped into the tree suspected of carrying concealed marks. This thoughtless practice leaves the next surveyor less evidence upon which to locate his line or corner, for the wanton chopping sets up favorable conditions for the decaying process to set in. Before resorting to the defacement of a bearing tree by chopping it, the surveyor should seek additional evidence to prove the position of the corner. Even if a court order should direct the surveyor to cut a section in order to inspect a tree suspected of being a bearing tree, he should place a permanent monument at the corner, whenever determined, mark additional trees, and file a record of such facts in the office of the county surveyor.

Searching for Corners from Bearing Trees

When a land corner stake cannot be readily found, a search should be made for witness trees that are described in the official field notes. If two or more witness trees can be found and properly identified as such, the point where the corner post or monument should be located will be indicated at the intersection of arcs described with the witness trees as centers and with radii equal to the recorded distances from the corner to the respective trees. Sometimes it will be noted that the location by distances will not correspond to the recorded bearings. A decision must then be made as to whether the intersection of the recorded bearings from the witness trees, the intersection of the recorded distances, or a com-

bination of the two should be used to determine the corner location. If by using bearings and distances from one witness tree the corner is located at a point such as to place it in a survey hacked line or an intersection of two such lines, with the cross or other mark on the witness tree facing the corner location, a proper location may be made. Any combination of these conditions which with other evidence will locate the corner at a point where it will harmonize with lines leading into it may also be a proper location.

Unique Method of Identifying Bearing Tree Stumps

About 13 years ago, a surveyor in Hardin County, Texas, was called upon to relocate an original survey corner in cut-over piney woods. The field notes at the southeast corner of the survey called for two pines while the adjoining survey called for three other pines. The surveyor, in running a trial line from an identified corner, did not find any timber standing at the desired corner. As there were many stumps in the vicinity of the corner, it was not possible to readily identify any stumps of the original calls. The location of every stump within a radius of 150 feet was taken and its position with relation to the trial line was plotted on a large-scale map. Another map on the same scale having the original calls was made and placed over the first map. The location of all of the original calls coincided exactly with the location of certain stumps and would not fit any other set of stumps. The paper determination of the corner in relation to the transit station hub was observed by this method and the corner was later staked on the ground.

Bearing Trees in New Descriptions

Occasionally in making a re-survey, or cutting off a divisional portion of a survey, a surveyor must prepare field notes to be used in a conveyance of some kind. While it is best to have permanent corner markers, and if possible make use of the official State Coordinate System, a pair of well selected bearing trees is very desirable. While the surveyor usually has no choice in making a selection of the bearing trees for numerous reasons, he should remember the following:

(*a*) Larger trees have lived a great portion of their natural lives and may be cut for timber.

(*b*) A good straight tree if desired by the lumber industry will be cut in a few years.

(*c*) Trees inside and along a roadway may be cut for future widening of the road.

(*d*) Trees on the bank of a stream may soon disappear due to erosion or widening the stream.

(*e*) Trees showing signs of decay will soon be dead.

Trees should therefore be selected if possible with a view to the length of their probable life, their relative location, their soundness, kind, size, and other favorable characteristics such as leaning, crooked, forked, double, etc. To assist in future identification of bearing trees where one is missing, the surveyor should mark different kinds of trees. The surveyor should carefully note the species, size, marks, peculiar characteristics, and the course and distance of the bearing trees from the corner. A properly described tree will usually be identified without uncovering the marks. When there are no remains of the bearing trees above the surface of the ground, traces of the roots will sometimes be sufficient to identify the trees. Sound trees, favorably located, having a diameter of from 6 to 12 inches, are to be preferred for bearing trees.

FIGURE 1.—Original witness tree (a cypress) on east bank of Neches River, Orange County, Texas—marked in 1883.

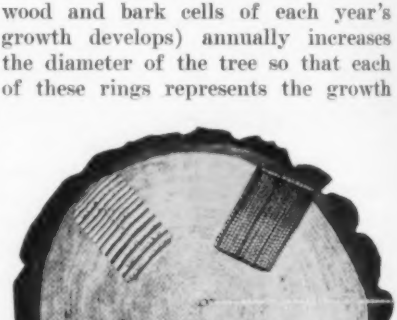
the tree makes during one year from the beginning of spring growth until the tree becomes dormant in the fall. Therefore, the age of a tree can be determined by counting these rings of annual growth. In exceptional cases prolonged periods of drought may retard growth, and favorable conditions later on cause it to pick up again, resulting in two rings being formed in one year. During years when there is a short dry season, narrow rings are formed, and during years when growing conditions are more favorable, wider rings form.

Each ring of annual growth is, in many woods, made up of two parts, (1) an inner light-colored portion known as spring wood, and (2) an outer darker portion known as summerwood. The springwood is made up of relatively large, thin-walled cells formed during the early part of each growing season.

THE TREE IN COURT

The tree as a bearing or line tree plays a prominent part in the land suits of the country. Frequently these trees in the form of cross sections or blocks are brought in the court-room for an expert examination as to age, kind, and size.

To determine the age of a surveyor's mark on a tree it is necessary to obtain a section of the tree containing a suspected survey hack and dress it in such a manner as will bring out clearly the wood features on which the reading of age is based. A cross section of a recently cut tree reveals a large number of concentric rings starting at the center of the pith and continuing outward to the bark. The wood tissue built up by the cambium (the layer of tissue just beneath the bark from which the new wood and bark cells of each year's growth develops) annually increases the diameter of the tree so that each of these rings represents the growth



C. J. Hogue

FIGURE 2.—Section of Douglas fir showing annual rings. Insert at left shows rings magnified to indicate springwood (light-colored section) and summerwood (darker portion); insert on right shows a single annual ring magnified to bring out fibers.

Summerwood is formed later in the year and is made up of cells having thicker walls and smaller openings in the cells. It therefore contains more solid wood substance than springwood, and appears to be darker in color. (*See* fig. 2.)

Either springwood or summerwood rings may be counted in determining the age of a tree. The person making the count naturally considers one wood as a "line" and the other wood as a "space." The determination of age of marks by counting tree rings pertains to the conifers and the deciduous trees and not to the palms, which do not possess heartwood, sapwood, cambium, nor true bark. Palms do not increase in diameter annually and grow only at the top, which denies us a knowledge of their ages. The story has been told of a surveyor in Florida who unsuccessfully experimented on the age determination of one species of palm tree—the date palm—by counting its fruit.

In presenting a tree section in a boundary lawsuit to show the age of the marks, the rings will be easier to count if "the finishing process leaves the surface smooth and free from tool marks, the cells free from wood particles, and their walls in place. These desirable conditions can best be obtained: (1) by using a sharp band saw in making a slight slanting, but perfectly plane cut, rather than a true cross-cut; and (2) by using a razor-edged block plane in strokes made with the grain, not against it. The slanting surface widens the exposed rings, while planing with the grain enables each successive layer of cells to back up or reinforce the cells being cut at any moment, thus assuring smooth, unimpaired cell walls and well-defined cell cavities. Even minute nicks in the edge of the plane will leave confusing tool marks; hence a perfect-edged plane should be used."[2] While sandpaper to smooth the surface is undesirable due to scratches and dust covering the cell walls, some surveyors use oils or stains to bring out the yearly rings. However, for a field inspection of the markings on the trees, one must be content with the use of an ax and cross-cut saw to remove the mark from the tree and dispense with the use of the plane to make the annual rings more visible.

In order for the age of a hack to be ascertained, it must have penetrated entirely through the cambium and into the wood. The cut as made by the surveyor remains for the life of the tree. Scar tissue forms over the cut and usually remains visible on the surface of the tree. Since the hack is always nearly parallel with the ground, and since it is a thin sharp line, cross-cuts through the bark may ruin the test. In cutting a block or section of wood containing the hack mark, it is necessary to make saw or ax cuts several inches above and below the hack and about parallel to the ground, and deep enough to pass the actual mark inside the tree. By splitting and wedging with an ax, the section is then removed from the tree.

In conclusion, it is recommended that all of us as land surveyors make a study of the growth of trees, the identification of trees in winter as well as in summer,[3] the marking of trees, and the healing of wounds. Recorded research by young

[2] THARP, B. C.: The Preparation of a Tree for Court, in the report of the Second Texas Surveyors' Short Course, General Land Office, Austin, Texas, December 5–6, 1941.

[3] "Forest Trees of Texas and How to Know Them," Texas Forest Service, *Agricultural and Mechanical College of Texas Bulletin No. 20*, College Station, Texas; also "Lists of Forest Trees of the United States," Miscellaneous Circular No. 92, *U. S. Department of Agriculture*, Washington 25, D. C.

surveyors under the proper guidance of experienced surveyors and woodsmen should help to preserve the bearing tree as a signpost for future generations of surveyors.

Is an Island Patentable?

THE QUESTION before the court is whether a fellow can build himself an island at sea, patent it, and so claim American sovereignty to it and the water for 3 miles around.

If so, what's to stop him from building a chain of islands around the world and calling the whole works the United States of America? Hey, State Department? Any suggestions, United Nations?

The U. S. Court of Customs and Patent Appeals, consisting of five black-robed judges in a mahogany-lined courtroom far back in a corner of the Internal Revenue Building, is trying to figure that one out now.

Attorney Randolph B. Cousins flew down from New York to represent John W. Flude, the Houston, Texas geophysicist and would-be island builder, in his battle with Casper Ooms, the Commissioner of Patents. Mr. Ooms did his talking through E. L. Reynolds of the Solicitor's Office.

Mr. Flude's idea is simple enough. There is oil under the sea. One way to get it is to build an island over the oil pool and then drill a well in the usual way. Only now you're out on your island in the ocean and if oil is gushing from the middle of it, odds are that some other nation will ride up in a battleship, chase you off, and plant its own flag.

Mr. Flude consequently applied for a patent on his invention to increase the size of the United States by building islands around the edges. He figured that would protect him from pirates. The Patent Office said an island is an island and you can't patent it. The inventor retorted that his kind of island was something special. Commissioner Ooms replied through his lawyers that the State Department might not like the idea. Mr. Flude said, so what? The Government said, well, what good was a U. S. patent on a dingus pumping dirt at sea outside the United States? Mr. Flude said fiddle-faddle; as soon as his island reached the surface of the water it would be a part of the U.S.A. The Patent Office turned him down. So did the Board of Patent Appeals. He filed notice of a further appeal to the Court of Customs and Patent Appeals.

The five gray-haired judges, two of whom were appointed by the late President Harding and all of whom work in almost total obscurity insofar as the public is concerned, waited expectantly in their handsome little courtroom.

Attorney Cousins hardly had begun his argument before one of the judges inquired:

"If we granted this patent, couldn't we claim sovereignty around the world?"

"If we build enough islands, we could," replied Mr. Cousins.

Another jurist remarked that many people had built islands but never asked for patents on them. Mr. Cousins said this was his client's good luck. Presiding Judge Finis J. Garrett wondered whether Mr. Cousins had conferred with the United Nations.

"Not yet," Mr. Cousins replied. He added that international politicians

and/or the State Department had no right to say whether Mr. Flude could patent an island. The jurists agreed. They said they'd decide the case on the law, with no thought whatever about the ideas of Secretary of State George Marshall.

"I don't know about global strategy," said Patent Office Lawyer Reynolds, "but I do know you can't invent an island."

Lawyer Cousins said he begged to differ. You can invent an island. Judge Garrett said the court would decide that—later.—Fred C. Othman in *The Washington Daily News*, January 11, 1947.

Western Planned Cities Date Far Back in History

PLANNED CITIES, such as Washington, are an old development in the Western Hemisphere, archaeologists have discovered. Peru had carefully laid out cities with geometrically patterned streets before the Incas, who were conquered by the Spaniards.

Scientists of the Institute of Andean Research this summr mapped 300 sites of early peoples in the Viru Valley of northern Peru, revealing portions of a story of 3000 years of human culture in the small fertile valley.

Dr. Gordon R. Willey of the Smithsonian Institution, who specialized in the settlement patterns of the early Peruvian groups, says that the 300 sites studied so far are probably about one-fourth of those in the valley.

Human beings have lived in the Viru Valley from about 1000 B.C. to the present, with eight distinct cultural periods up to the time of the Spanish conquest.

The planned cities, which did not appear in Europe until well into the metal ages, have been unearthed in northern Peru among the remains of a culture before the Incas.

In these early cities, there were places assigned for temples, other public buildings, storehouses, and dwellings. Largest of the cities was Chanchan, by far the largest city in the New World before white men came. Dr. Willey believes these planned cities were developed by a culture in which everybody knew his place and lived according to a prescribed pattern.—*Science News Letter*, December 14, 1946.

Third National Surveying Teachers Conference

ON AUGUST 10th to 20th, engineers, educators, and instrument manufacturers will meet at the Washington State College Survey Camp in the Snoqualmie National Forest, 50 miles west of Yakima, for the Third National Surveying Teachers Conference on Surveying and Mapping, the first in 7 years. The conference is being held under the auspices of the American Society for Engineering Education.

The theme of the conference will be the challenge and the opportunity that recent developments in the fields of surveying and mapping are presenting to engineering education.

Land Surveying in Maryland

By EDWARD V. COONAN

PRESIDENT, EDWARD V. COONAN & CO., SURVEYORS & CIVIL ENGINEERS

WHEN the first settlers came to Maryland there had not been prepared any plan or scheme as to how the land should be parceled out to them, although each settler was entitled to a certain amount of acreage for himself, his wife, his children, and for each person he brought into the Colony. Under the system, every parcel of land granted to the settler was subject to a yearly rent payable to the Lord Proprietor, who collected an alienation fee when the parcels changed ownership. Parcels of land also reverted to him by escheat.

The Early Days of the Maryland Land Office

It soon became obvious, for the protection of all parties concerned, that the number of acres due the settler would have to be ascertained and surveyed to determine the boundaries, and to have a description thereof embodied in a deed or grant (called a patent) and recorded in some permanent way. To effect this, the beginning of what eventually became the Land Office of Maryland, was created in 1637. All the land affairs were conducted in this Office and all papers relating to land business were recorded there. The Office made rules and regulations for the disposition of the Proprietor's land, collected his rents, and controlled the surveying, issuing of grants, and recording them in the Office. A Surveyor General was appointed by the Proprietor and controlled the Land Office. He appointed Deputy Surveyors in each county, who were sworn officers of the Province and State. The Deputy Surveyors worked only through the Land Office and were strictly controlled by the Surveyor General's rules and regulations. After the Revolution these surveyors were, and still are, elected by the people, and the Land Office is controlled by a Commissioner who is appointed by the Governor of the State.

The early rules and regulations of the Land Office were made principally for the benefit of the Proprietor and were changed from time to time to protect him from the acquisitiveness of the settlers and land speculators. In 1712 Charles Calvert, the third Lord Baltimore and the then Lord Proprietary, thinking that he was being defrauded, wrote to the Surveyor: "In the future you are, either by instructions to my surveyors or by proper words inserted in my warrants, to so order matters that in all surveys hereafter to be made there will be but one bounder or certain beginning expressed and sufficiently described, and after that nothing but the course and distance to the closing line." That meant that there should be no calls for adjacent lands or their boundaries, and that the course and distance of the closing line should be omitted. As late as 1768 the instructions of the surveyors required that this line should always be expressed "thence with a straight line to the beginning." This closing line in old deeds and conveyances is called the "Giving" or "Given" line. Other instructions from the Land Office to the surveyors regarding the method of surveying various kinds of warrants, for re-surveys, and the inclusion or exclusion of certain kinds of land, caused additional confusion and complications.

After the settler had selected the land he wanted and had proven his claim,

a warrant was sent from the Land Office to the County Surveyor directing him to survey the land approximately described in the warrant, in the name of the settler, and return a certificate and plat of the land together with a full description thereof and a statement of its area. All of this had to be done exactly as the instructions to the surveyor required. If this passed the examination in the Land Office, a patent was issued to the settler bearing the Great Seal of the Province and signed by the Governor. A copy was recorded in the Land Office where it can be found to this day.

These patents are the only basic titles to all the lands in Maryland. The descriptions of land in them are important, as they determine the size and location of the tracts of land and their boundaries.

The Early Surveys

In earlier times there were no means of fixing boundaries permanently, so the descriptions began at a marked tree or group of trees. The kind of tree was named and the location mentioned by reference to some place, such as "on the North side of a creek or stream descending into Patapsco River near the Beaver Dam," or by other words referring to natural features of the vicinity. Succeeding lines were then run by courses and distances to other marked trees, but the last line of the survey was always omitted.

Such markers were indefinite and unstable. The trees rotted or were blown down by storms or cut down inadvertently or intentionally, and were difficult to identify. All of this occasioned much trouble and controversy, so much so that in 1699 the Maryland Assembly passed "An Act to ascertain the bounds of land" and therein directed how the confusion in lines should be corrected. In 1715, 1718, and 1720, somewhat similar acts were passed for the same purpose and to quiet titles.

From time to time, as land in Maryland became more valuable, the larger tracts were divided into smaller parts; and many lawsuits were occasioned by faulty surveys, bad conveyancing, and mistakes in copying descriptions into and from the Land Records. Most of these suits went to the Court of Appeals, so that today there are few questions concerning property lines that are not covered by legal decisions.

The earlier surveys were made with a navigator's compass. The courses were given in points and fractions of points; later all surveys were made with the chain and the familiar surveyor's compass, with which a course could be read by estimation to 15′.

Although the vernier was invented in about 1631, there were generally no surveyors' instruments with a vernier until about 1815, when the theodolite came into use. This instrument was rarely used in Maryland, and it was not until the advent of the transit, in about 1830, that land surveyors began to survey by angles. Even then the compass was still generally preferred, and it is still used where land is cheap.

The many obvious defects of surveying with chain and compass were well known to the early surveyors, but by constant practice they acquired great skill in using these instruments. They made surveys of sufficient accuracy for calculating areas, for dividing land, for descriptions in conveyances, and for other purposes. They had a rule that if the error in closing a survey traverse exceeded 1 link in 5 chains, the work should be repeated.

Plats were made by scale and protractor or by Gunther's scale, by which angles could be laid down with the assistance of a pair of dividers. The survey when drawn was divided into triangles, the sides scaled and the area of each calculated.

The work of the land surveyor is much the same now as it ever was. He has to determine areas, divide land, fix boundaries, and write descriptions of parcels for conveyancing; but because land has increased so much in value, his work now is much more exacting. Modern conditions require minute examination of land titles by expert conveyancers and lawyers. Some titles are heavily insured, so that a much more comprehensive survey and determination of lines are required than formerly. Therefore, the surveyor must know how old title lines were run and how to reproduce them, and how to adjust their differences according to court decisions relating thereto, of which he must have a working knowledge. Where land is valuable, land surveying is a highly specialized business, not to be undertaken lightly by those not qualified by training and experience.

Britain's Land Laws

PUBLICATION of the town-and-country-planning bill, which the Labor government will soon lay before Parliament, appears to be, both theoretically and practically, the most pronounced item yet presented in the socializing process which Britain is now undergoing. This is admitted by Lewis Silkin, minister of town-and-country planning, who describes the bill as "almost revolutionary" in character.

The bill practically abrogates the principle of freehold land tenure which has been a traditional Anglo-Saxon institution. No longer may any landowner in Britain "do as he will with his own" or profit by the use he makes of his land if this involves any change in its utilization.

Outright nationalization of the land is, to be sure, avoided; but, practically speaking, the scheme nationalizes all profits from the development or improvement of any land, urban or rural, in Great Britain.

The nationalization of land-profits is accomplished by what is termed a "development charge." Here is how it will work: Suppose farm land is cut up into lots for a suburban real estate development or a residential section in a city is transformed into one of stores and movie houses. Such changes imply more profitable uses. The state determines the amount of "unearned increment" and imposes a development charge which could legally be 100 percent, but which Mr. Silkin thinks will average between 75 and 80 percent. Further, this bill should be bracketed with another sweeping measure now before Parliament, the so-called land charter measure, under which the government intends to boost agricultural efficiency by close government supervision, dispossessing farmers who disregard official advice as to how they shall farm and what they shall raise.

These measures have already evoked strong Conservative criticism and may be expected to be hotly debated, in and out of Parliament. But they all have the backing of the Labor majority and so may be expected to become law. Once they are in effect, the face of Britain will indeed be changed—perhaps almost out of recognition as compared with its traditional past.—Editorial in *The Washington Evening Star*, January 18, 1947.

The Responsibility of a Profession to its Teachers

By LOUIS H. BERGER
PRESIDENT, C. L. BERGER & SONS, INC.

THERE has been for some time a growing consciousness among engineers that professional unity is important to themselves and to society. In an age when scientific and engineering developments play such a dominant part in world affairs, it is clearly necessary that those who are engaged in the various phases of technological activity should unite in planning for the enhancement of the profession and for bringing the viewpoints of the group as a whole to bear effectively upon current social, economic, and political problems.

Much has been accomplished in recent years toward this objective through Engineers' Council for Professional Development, Engineers' Joint Council, National Society of Professional Engineers, and other agencies both national and regional. Very significant contributions have been made by the American Society for Engineering Education (formerly the Society for the Promotion of Engineering Education) which is comprised primarily of engineering educators. Men who guide the oncoming generation of engineers while they are absorbing the fundamentals of technical knowledge and skill are obviously in a strategic position to co-operate in the movement toward unification of engineering as a profession.

The purpose of this paper is to consider the status of the engineering teacher, to indicate how he can be signally helpful in the movement toward professional solidarity, and to suggest the need for improving the teacher's position if he is to achieve maximum effectiveness.

Exacting Qualifications For The Engineering Teacher

Some 10 years or so ago at a summer conference for engineering educators sponsored by the University of New Hampshire the discussion one warm afternoon was focused upon the qualifications of an engineering teacher. It was an interested and lively discussion to which the 25 or 30 conferees contributed a wide variety of experience and viewpoint. Before the afternoon was over, the blackboard was filled from one end to the other with lists of the qualities, characteristics, and abilities that mark the successful engineering teacher.

It was a very fruitful exercise for many who were present because they had not fully realized previously what exacting requirements must be met by those who train our engineers of tomorrow. Without attempting to make an exhaustive review of these requirements, it may be worthwhile to examine briefly what we expect the teacher to be and to do as a member of an engineering faculty. This is a helpful preliminary step to an inquiry as to whether the initial status and opportunities for advancement generally available to engineering teachers are such as to attract and develop suitable men for the staffs of our engineering schools.

In the first place, the teacher should be a person of unimpeachable character with personal qualities of speech and manner to which students will be responsive. Many of the most valuable outcomes of formal education are achieved by the process of being caught rather than taught. Students tend to emulate the able,

personable instructor whom they admire and respect, and who shows an interest in them as well as in the subject he teaches. Such a man will spend many unscheduled hours outside of class exercises in helping students individually, in counseling them about their personal problems, and in participating with them in extra curricular activities.

Then, of course, the instructor must be thoroughly competent in the subject matter he professes to teach. This implies many years of careful study and experience. In addition he must spend on the average of 2 hours in anticipation of each lecture to plan his material and method of presentation. Then there are papers to correct, examinations to prepare and later to read, grades to be readied, and so on through a multitude of academic chores that must be done on a time schedule. Between times he keeps abreast of his field and broadens his understanding of professional matters by perusing the technical literature which seems to be increasingly prolific and voluminous.

As mentor and guide to engineering students the instructor will be expected to take a leading part in professional society activities. There will be at least one or two and probably nearer a half-dozen organizations that will have a claim upon his money, energy, and time. This is frequently over and above the community responsibilities in which he must share: the church, the Boy Scouts, the local government, the Community Chest, etc. More than likely he will also be selected to serve as advisor to some student organization at the engineering school, a very useful but time-consuming aspect of his college duties.

Increasing emphasis is being placed upon the importance of research, and every engineering school tries to inculcate in the undergraduate a sense of the importance of original investigations looking toward the extension of technical knowledge and its applications. In this the engineering teacher plays a significant part. While the policies of different schools vary considerably, it is more and more expected that the teacher will take some part in research and development. Sometimes his eligibility to advance in rank and salary is contingent upon his producing creative work that will enhance his professional status, and also that of the institution on whose faculty he serves.

Textbooks and laboratory manuals have to be written. There are invitations to speak to professional and community groups. Conferences and committee work lay claim to sizable portions of the teacher's time. Most of these duties are labors of love and bring in no appreciable income for the family budget.

In fact the more unselfish the man, the finer he becomes as an example to his students, and the less time he will have available for earning extra money. Sometimes the engineering teacher may be able to supplement his salary to a limited extent by carrying on a small consulting practice on the side, but if he is to give his energies as fully as he ought to the work of the college, he will not be able to handle much of this. Moreover, consulting activities of the engineering teacher are subject to institutional policies and are usually so restricted as to avoid competition with full-time engineering practitioners.

Salaries Should be Commensurate With Obligations

It would seem then, in view of the importance of the job carried on by the engineering teacher, the comparatively high qualifications that are required of those who are to discharge this responsibility well, and the exhausting nature of the duties involved, that salaries generally available for such service should be

substantial. But studies that have been made by the S.P.E.E. and the Association of Land Grant Colleges in the past have revealed a striking disparity between the requirements for engineering teaching and the salaries paid to engineering teachers. There are some exceptions, of course, but taking the country by and large the field of engineering education has not compared favorably with that of engineering practice in terms of monetary reward.

Some people feel this is as it should be, that a person should not enter a teaching career unless he is prepared to make financial sacrifices. But is this a wholesome way in which to look upon that segment of the engineering profession upon which we depend for the training of our successors? The income of the engineering teacher should be adequate to permit his giving full attention to the job of teaching without having to diminish his effectiveness by seeking other ways of maintaining his family.

In times of rising living costs the teacher is particularly hard-pressed. He is sorely tempted to relinquish his instructional responsibilities and accept industrial employment where the monetary rewards are more attractive and the opportunities for advancement more rapid. During the war and since, engineering education has lost many an able teacher for this reason. These losses are difficult to replace, for it takes many years of devoted effort to acquire the technique of instructing and the skill in counseling that mark the mature teacher. The wartime shortage of engineers, which bids fair to continue for several years ahead, makes the situation even more difficult. With industry bidding eagerly for young graduates at relatively high salaries, is it any wonder that capable engineering teachers ask themselves whether they ought not to capitalize upon their professional skill in fields which yield more adequate salaries?

The American Council on Education reported in its June 14, 1946 Bulletin on Higher Education and National Affairs that the average salaries of college teachers had increased only about 20 percent during the period from 1939–40 to 1946–47, while the cost of living had risen over 30 percent during the same period. Taking into account that teachers' salaries were not considered adequate in 1939–40, this obviously means that educators are facing a very difficult situation now. The only way to correct this is to improve the financial condition of our colleges and universities so that they can pay their teaching staffs higher salaries.

There are hopeful signs upon the horizon. A number of institutions have announced increases in tuition to be effective soon, coupling this announcement with a statement that this would permit increases in salaries. There is a growing realization that an able, devoted faculty is the keystone of an engineering school. Fine buildings and elaborate equipment are great assets in education but without the influence of consecrated teachers they are powerless to produce capable engineers and constructive citizens. It is very difficult to attract, develop, and maintain able teachers when salaries offered are far below the wages paid to bricklayers, mechanics, and sometimes even to production line workers. The teacher is worthy of his hire and should be paid enough to keep his self-respect and meet the obligations of his position in the engineering profession.

Now is the time to correct this long standing disparity between what teachers are actually paid and what they should be paid. Reconversion is going on all about us; new standards and criteria are being established all along the line. It is important that the profession be mindful of its teachers so that at least a fair share of the best talents in engineering be recruited and retained in our engineering schools.

Surveying From a Desk

By J. P. SMITH
PHOTOGRAMMETRIST, UNITED STATES BUREAU OF RECLAMATION

U. S. Army Air Forces
AERIAL PHOTOGRAPHY MAKES SURVEY OF COLORADO RIVER REGION POSSIBLE

IT WAS less than a century ago that such intrepid adventurers as John C. Fremont and Major John Wesley Powell took their surveying parties into the wilderness of the West where members of the parties suffered catastrophic privation, hunger, exposure, illness, and death.

Today, a survey can be made from a desk in a warm, comfortable office. This new science is known as photogrammetry—the art of obtaining surveys from photographs. Such surveys are obtained from the interpretation and treatment of aerial photographs. Through the use of photogrammetric processes, topographic maps for engineering purposes are compiled to any desired scale with contour intervals as small as 1 foot. Maps prepared by this method are being more and more widely used in Bureau of Reclamation work.

The work of photogrammetrists has proven to be an invaluable aid in geologic studies. The geologist uses a mosaic of aerial photographs as a base map, along with stereoscopic studies of paired prints, for preliminary investigations.

The study of landforms, drainage patterns, and distribution of vegetation, yields valuable clues to geologic conditions in proposed dam site and reservoir areas. Faults, landslides, location of bedrock outcrops, sequence of rock strata, and other geologic conditions important to the engineer can be readily investigated by the use of photogrammetric processes allied with geologic principles. In addition, the nature of the problems and the areas of most profitable study can be outlined for subsequent field investigations.

Reprinted through the courtesy of *Reclamation Era,* March 1947.

A wealth of information is obtained by photogrammetric processes which might otherwise be neglected because of the large areas involved, the time element, and the high cost of ground surveying.

Working at a desk from photographs, the Bureau photogrammetrist prepares a detailed survey of projects under investigation such as the site for a dam, a reservoir, a power plant, or the routes of tunnels, canals, and laterals. Photogrammetry is also used for related engineering studies such as determination of reservoir capacities, location of power transmission lines and roads, and classification of land.

The tremendous advances made in aerial photography and the interpretation of aerial photographs during the war have resulted in wider use of photogrammetry. The aerial photographer flies over a predetermined flight line using a special camera equipped with an auxiliary instrument known as the intervalometer; by means of a motor, the intervalometer operates the camera automatically, winding the film, setting the shutter, and tripping it at regular time intervals. Most aerial photographs are taken between 11 A.M. and 2 P.M. because at this time of day any shadows which might obliterate ground detail are reduced to a minimum.

An additional field of photogrammetry, which shows great promise, is the location of material deposits for construction purposes. The investigations made in this new field of application are now adequate to assure that the preliminary location of construction materials deposits by this method is a practical engineering operation.

The steadily increasing use today of photogrammetry in engineering and geologic fields is a logical development, since this science provides many advantages over the arduous ground-surveying methods in (1) a saving in time of months, and in some cases even years, (2) a more thorough survey, (3) greater over-all economy, and (4) availability of data not obtainable economically by other methods.

* * *

Aerial Surveys Ordered for Western Dam Projects

THE BUREAU OF RECLAMATION and the U. S. Army Engineers have announced the award of contracts for aerial surveys to determine feasible locations of dam sites in the West.

The Bureau awarded a $139,560 contract for a topographic survey of portions of the San Juan River in Utah to Fairchild Aerial Surveys, Inc., Los Angeles, California. The Engineers' $5,180 contract went to Wallace Aerial Surveys, Spokane, Washington, for 1,070 flight-line miles of aerial mapping photography on the Snake and Salmon Rivers in Idaho.

The Fairchild survey, which will cover the canyon section below Goodrich and the Bluff reservoir site, is part of a study being made to develop San Juan basin water resources and provide silt control for the protection of Lake Mead and the entire lower Colorado basin development program.

Wallace photographs will cover the Snake River from Lewiston, Idaho, to Huntington, Oregon, and the Salmon River from its mouth to its junction with the north fork.—*Engineering News-Record,* August 1, 1946.

Field-Completion Surveys

By GEORGE D. WHITMORE
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THE QUESTION of which are the most efficient procedures to follow in completing maps prepared from aerial photographs has been given little consideration by the surveying and mapping profession. It is hoped that the following discussion, which deals only with the generalities of the subject, will be illuminating to those who have had little or no experience in this field, and at the same time will be thought-provoking to those who are experienced in it. For the author's convenience, the discussion is arranged as a series of questions and answers, which are intended to cover only briefly and generally the *why*, the *wherefore*, and the *how* of field-completing photogrammetrically-compiled maps.

The views and observations expressed are the author's personal ones, and should not be interpreted as necessarily reflecting the official policies of the Geological Survey.

1. What is field completion, and why is it necessary?

It is well recognized that a photogrammetrically compiled map seldom can be made entirely complete in the office. There are many features required to be shown on the final map which cannot be obtained directly from the aerial photographs; for example, place names and feature names, corners and lines of the United States land subdivision system, political subdivision boundaries, cemetery boundaries, classification of roads, classification of buildings, etc. Field surveys and field investigations are therefore necessary to make maps complete—hence the term "field completion."

A map compiled by aerial photogrammetry may be incomplete in other respects. There may be difficulty in completing the contours or the drainage patterns, because certain photographs give unsatisfactory models, or because the terrain is covered with dense woodland so that the ground surface is hidden from view. Or the terrain in certain areas may be quite flat, and half-interval supplementary contours are required. Unless special low-altitude photographs have been taken ground-survey methods will be necessary to complete the map.

It is obviously impractical to determine everything that a photogrammetrically compiled map may need in the way of completion work without giving the map a thorough field inspection. Field inspection is defined, for the purposes of this discussion, as a careful comparison of the terrain with the map, for the purposes of determining: (1) what features have been omitted from the map, and (2) what features have been incorrectly shown. This explains why the field-completion operation has been sometimes called "field inspection," or "field inspection and completion." At the present time the term "field completion" seems to be generally preferred, although "field edit" is also in use. The inspection, correction, and completion operations are usually done all at the same time, by the same field party.

Presented at meeting of Washington, D. C., Section, American Congress on Surveying and Mapping, February 18, 1947.

There is still another important operation which is often associated with field completion. The regular operation of inspecting, which is ordinarily applied to all sheets, gives *evidence* as to each map's accuracy, but in addition it is desirable that on some of the map sheets a series of special accuracy-testing surveys be executed, to provide *proof* that the maps are complying with the specified accuracy. Such formal testing work is not necessarily a part of field-completion surveys, but in some organizations the same party which handles the field surveys also handles the accuracy-testing surveys, for reasons of economy. These test surveys necessarily must be of a higher order of accuracy than the map-compilation or map-completion surveys, otherwise they would not furnish positive proof that the map does or does not meet specifications. For that reason, and also because it is sometimes desirable to have disinterested persons doing the testing work, the accuracy-testing surveys are often handled by different personnel, and done as an entirely separate operation from field completion.

2. On what types of photogrammetric mapping is field completion required?

Field-completion surveys are generally regarded as absolutely necessary for all of the Federal Government's standard topographic quadrangle maps, on scales of 1 inch to the mile and larger, which are prepared mainly by photogrammetric processes, and correspondingly are also regarded as necessary for most of the large-scale topographic maps which are so prepared for engineering projects. They are also generally regarded as necessary for similar-scale planimetric sheets, although in planimetric mapping, the schedule of operations may sometimes be advantageously arranged quite differently. Briefly, the rule should be that field-completion surveys should be required whenever the final maps are to show details and features that cannot be obtained from either the aerial photographs or from existing office records. An obvious and necessary exception to this rule is the mapping of enemy-held territory in time of war. Field-completion surveys are usually not necessary for very small-scale maps compiled from aerial photographs, because for such maps the amount of detail to be shown is much less than for the larger-scale maps, and such details and features as cannot be procured from aerial photographs can often be obtained from existing maps and other records.

The preparation of large-scale planimetric maps presents a special case. There are many such mapping projects where it is entirely satisfactory procedure to do a part of what has herein been described as the field-completion operation in advance of the map compilation. In that case, the photographs are taken into the field at the time control surveys are being executed, and all features intended to appear on the final map are interpreted and delineated and suitable explanatory notes added. It is then the office photogrammetrist's responsibility to get all of these delineated and noted features plotted on the map in correct position. Then, with a simple office check, it is assumed that the map is complete, and that no further field inspection is necessary.

This advance-interpretation procedure is not entirely practical for topographic maps because with them one of the major operations of field completion is inspecting, correcting, and completing of contours, and this cannot be done until after the map has been compiled. It is true, however, that in a topographic mapping project the field completion of most of the planimetric features can be done in advance of the map-compiling operation, leaving the rest for the later

operation. This, as a matter of fact, has been done quite frequently, with entirely satisfactory results. So far there seems to be no clear evidence as to which procedure has the greatest advantage, although there is some indication that splitting the operation, which requires that the ground be covered twice by two different field parties, is more costly than doing everything in one operation after the map has been prepared in the office.

3. Do all civilian mapping organizations, governmental and private, engage in field-completion surveys as a regularly scheduled operation?

It must be admitted that a categorical "yes" or "no" answer cannot be given at this time. Probably most organizations making medium- and large-scale topographic maps follow the general procedures herein outlined. There are possibly a few which rely on the procedure of obtaining the necessary planimetric details by the advance photo-interpretation method, but forego sending the sheets to the field later for field inspection of the contours. This is regarded by many leaders in the mapping profession as a serious mistake, because those organizations which do engage in regularly scheduled field-completion work have found numerous cases where, although the photogrammetrically compiled map appeared correct and looked adequate in the office, based on the evidence in the photographs, the field inspection nevertheless showed it to have some serious deficiencies. Thus, generally speaking, those organizations which do not regularly schedule a final field inspection of each topographic map sheet, run considerable risk of turning out seriously deficient, sub-standard work. Experience would indicate that in no case so far has the final field inspection of topographic maps been wasted effort.

4. Is there a standardized field-completion procedure?

The answer to this question is undoubtedly "No." The use of photogrammetry in the preparation of standard-content and standard-accuracy topographic and planimetric maps is still relatively new, and each of the several mapping organizations still has its own ideas as to what are the best techniques. The procedures and techniques of field completion are constantly undergoing change. It is probable there will develop, sooner or later, a clear preference by all mapping organizations for what will be regarded as a standardized field-completion procedure.

5. Are there any published instructions on field-completion procedure, available to the public?

The answer to this question is believed to be "No." Some organizations have mimeographed or lithographed technical instructions for use within their own organizations, but these are generally brief, are subject to change, and are not intended for public distribution. It is also worth noting that there are no textbooks available which attempt to treat the subject comprehensively.

6. How are field-completion surveys conducted in the field?

The answer to this question can only be generalized, of course, because each different map sheet presents a different problem to the field-completion engineer, and the kind and amount of field work required may vary considerably from sheet to sheet. Under the procedures currently in use by two of the governmental organizations, the work usually proceeds about as follows: First, the field engi-

neer makes a rapid automobile reconnaissance over the entire area of the map sheet, driving most of the passable roads, making general observations and specific notes as to the apparent quality of the map, the places where topographic information is missing and needs to be filled in, the best means of automobile or foot access to the different parts of the sheet, and similar matters. This rapid reconnaissance and the resultant appraisal permit the field engineer to plan the work intelligently, and to issue instructions to subordinates. It is undoubtedly well worth while.

The field engineer then usually makes a detailed inspection of the sheet, this time driving very slowly over each road, and walking out the impassable roads. He is equipped with a planetable, and wherever he notices missing features, he makes a setup, or runs planetable traverses, and locates the missing features on the map. As he covers the roads he notes the proper road classification on a road-information sheet. He classifies the buildings. He deletes with inked cross-marks those features appearing on the manuscript sheet which are unwanted or unnecessary on the published map.

He carefully notes the map's contours, and compares them with actual ground features. If the contours at any point look doubtful, he may stop, make planetable setups, and take a few "shots" to check the map. He redraws the contours where they are found weak in accuracy, or poor in topographic expression. He is likely to particularly examine the contours along and adjacent to the main highways, to make sure that the map's contours correctly depict the man-made topography, such as occurs in the vicinity of cuts and fills, bridges and culverts, overpasses and underpasses, and similar features. One organization requires its parties to make a complete planetable traverse of each main highway, in order to insure that these features, often difficult for the photogrammetrist to interpret correctly, are accurately depicted.

He confers with local residents for the purpose of obtaining data on local names, political boundaries, land subdivision lines, and similar matters. He consults the county or state records for names and other information that cannot be definitely determined during the field trips.

On many sheets the terrain is partly hilly or mountainous, and partly very flat. Several mapping organizations require that the map show half-interval supplementary contours for these flat areas. Since the plotting of these smaller-interval contours is also usually considered to be a regular part of field-completion work, the field engineer will be obliged to completely contour such areas. Similarly, he will have to completely map those blank areas on the map which the photogrammetrist, for one reason or another, had to omit, or had to classify as weak. It has been found on numerous map sheets that, despite the best efforts of well-trained photogrammetrists, the largest single item of work for the field-completion engineer is correcting and completing the map's contours.

7. What training and experience are required of the field-completion engineer?

In the opinion of many highly-placed engineers, field-completion work should be entrusted only to well-trained, capable topographers, because an important part of field-completion work is topographic mapping. It is true that a capable engineer of limited experience can be trained in a reasonably short time to handle efficiently many of the items included in a field-completion survey, but the most critical work—the evaluation of the topography, and the topographic mapping

or remapping of many areas—requires the highest degree of professional judgment and can best be done by a good topographer.

It may be asked, in that case, why not split the work and let the less experienced man handle those items which he can quickly learn to do, and leave the topographic work for the topographer? That also has been tried, and, while it will work, it has not so far demonstrated as much economy as entrusting the entire job to a well-trained topographer.

It is now becoming generally known that the contours for the flat areas of photogrammetrically compiled maps are often surprisingly weak in accuracy. Hence, there is a growing tendency for the photogrammetrist to omit the contours in flat areas, and leave these to be completed by planetable surveys later. This would seem to be sound basic procedure, because obviously the photogrammetric process is most advantageous in the hilly country and is at the greatest disadvantage in flat country, whereas the exact opposite is true for planetable surveys. There seems to be little doubt that the basic topographic mapping process of the future will provide for office photogrammetry to produce all of the planimetry, but contours of only the hilly portions, leaving contours of all flatter areas to be done by professional field topographers. As a matter of fact, there are many map sheets now in process where this is the intended procedure.

8. What size and type of field party is usually used on field-completion work?

Usually the field-completion party consists of two men, the topographer, or engineer-in-charge, and a rodman who also doubles as driver of the car. Much of the work can be done without leaving the automobile, and for that reason it is well to provide a car that will allow good visibility in all directions.

The special surveys for accuracy testing are sometimes run with transit and tape, and in that case a 4-man or 5-man party would be economical. When circumstances are such that the field-completion parties have to handle this work, it has been suggested that two of the 2-man parties might temporarily join forces for this purpose.

9. What percent of the total mapping process, or the total mapping cost, is field completion?

Obviously no absolute answer can be given to this question, because field-completion costs will vary according to the quality of the photogrammetric mapping, the specifications that are required on the final map, the type of country covered by the map area, and several other factors. However, a broad general answer, based on the experiences of two mapping organizations and observations of several others, would be that the cost of field-completion work will usually be somewhere between 10 and 30 percent of the total mapping cost. "Total mapping cost" is intended to include the cost of all of the map-making operations, beginning with control surveys and aerial photographs and ending with map reproduction. A field-completion-cost ratio as low as 10 percent can be attained only under the most favorable circumstances. Probably something of the order of 20 percent, or possibly even 25 percent, would be the optimum ratio. However, there have been some cases where the field-completion work ran to 50 and 75 percent of the total mapping cost, and justifiably so.

10. What operations are required after the field-completion surveys, in order to prepare the manuscript maps for reproduction?

The original photogrammetric map compilation sheet is seldom actually taken into the field. Usually, reduced-scale photographic copies, often printed in blueline form, are used as field sheets. On these all of the additions are marked in ink or pencil, and all of the desired deletions are indicated with inked cross-marks. Supplementary information, such as names, road classifications, etc., is ordinarily shown on extra photographic prints, or on transparent oversheets. These photographic copies are then returned to the map drafting office, where the additions are transferred to, and the deletions are removed from, the original manuscript sheet. These office operations are known in some organizations as "office completion."

There have been a few cases where the changes and additions to the original sheet resulting from field completions were so numerous that it was advantageous to completely pencil the blueline field-completion sheet, and use it as the camera copy for the preparation of color-separation boards. The test is, of course, whether it is less costly to completely repencil a blueline field sheet, or transfer the corrections and additions to the original photogrammetric manuscript sheet. In case it is suspected at the start of the field-completion survey that there is some likelihood that the field sheet may become the camera copy, the field copy should be printed in non-photographic blue on a metal-mounted sheet, in order to be certain of having correct-scale copy for the camera work.

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Co-ordination of Surveys

ALL ENGINEERS who work with land surveys of any kind—townships, city subdivisions, roads, streets—are eternally bedeviled by inaccuracy and lack of co-ordination in those surveys.

In assembling maps of a city, it is rare that subdivision plats will agree with each other or with the government land surveys. The difficulties are so common and so persistent that engineers engaged in this work must spend a large percentage of their time and efforts in fitting old and inaccurate surveys together.

It is too late to completely correct old surveys, but it is never too late to start a new system that would eliminate much of this trouble in the future.

A bureau of surveys, composed of competent engineers of the United States government, the state government, and local governments, could be set up to pass on all surveys in the state. Any survey and map made by any engineer for a private party, for a business corporation, or for any governmental agency, should be submitted to this bureau, which would check the survey or map for accuracy and for co-ordination with all adjoining surveys and maps. Only maps approved by the bureau could be recorded in the state. In this way, after years of such checking, the errors and disagreements which are expensive evils in this branch of engineering, would begin to disappear.

The idea of a survey bureau has not been adequately studied. It calls for much discussion and planning. But the idea is sound and in the direction of more efficient service by engineers.—Editorial in *The Engineers' Bulletin*, Colorado Society of Engineers, January 1947.

Electronic Aids to Marine Navigation and Surveying

By THOMAS J. HICKLEY* *and* C. M. JANSKY, JR.†

LAST MONTH we were privileged to attend the International Meeting on Radio Aids to Marine Navigation, which was held in London. The object of this meeting was to familiarize maritime nations with many of the radio aids to navigation, most of which had been developed as a result of the war. An effort was made to evaluate these aids to discover their possible value for marine navigation, with the hope that in the future there will be such uniformity in systems that they will be useful on a world-wide basis.

Because navigation and hydrographic surveying and charting are so closely related, much of the discussion at this meeting was of interest to the surveyor. Of special interest were those radio systems which, in their present state of development, are sufficiently accurate for surveying. Of equal interest was the consideration of what changes will have to be made to nautical charts in order to adapt them to the use of the new electronic aids.

A number of systems were described and demonstrated. A few of these were Loran, Gee (which is a high frequency Loran system), Consol (a land-based azimuth measuring system), Radio Beacons, Radar, and Decca. Of these systems, Radar and Decca are sufficiently accurate that they may now be used as surveying instruments.

The Decca System

Decca is an intermediate range navigating system developed in Great Britain. It resembles Loran in that it employs master and slave stations and uses a latticed chart, which resembles the Loran chart. It differs from Loran in that phase differences of continuous radio waves are used as contrasted to time differences between pulse radio signals as are used in the Loran system. Figure 1 illustrates a Decca system. It will be noted that the master is common to two slave stations. The families of lines are hyperbolic curves, each point on the curve being a constant difference of phase between two radio signals emanating from the master and its associated slave station. Each curve is thus a line of position. By identifying on his chart the two lines of position from the instrumental readings, the navigator can obtain an intersection which will fix the position of his vessel. The solid system of lines in the figure belong to the master "M" and slave "R," and the broken system to the master "M" and slave "L."

The receiving apparatus carried by the mobile unit is capable of measuring the phase between adjacent lines which bound each lane. It is first necessary that the navigator know which lanes he is in; his instrument will then show his position within the lanes. From then on, his instrument will continue to show him his position regardless of where he moves over the latticed chart.

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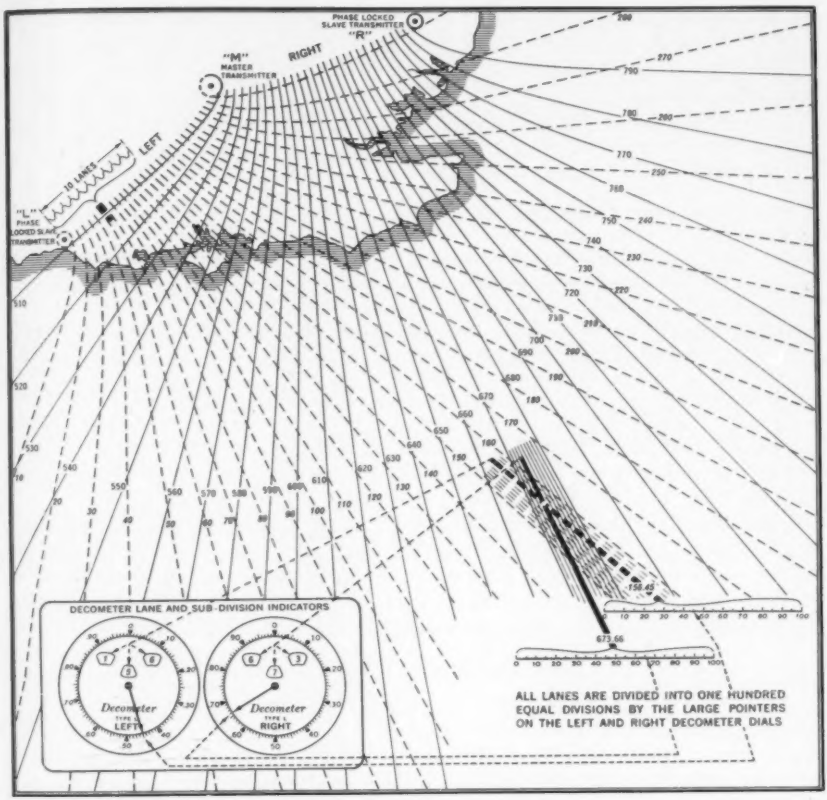
PHASE LOCKED SLAVE TRANSMITTER "R"
"M" MASTER TRANSMITTER
RIGHT
LEFT
10 LANES
"L" PHASE LOCKED SLAVE TRANSMITTER
DECOMETER LANE AND SUB-DIVISION INDICATORS
Decometer TYPE 1 LEFT
Decometer TYPE 1 RIGHT
156.45
673.66
ALL LANES ARE DIVIDED INTO ONE HUNDRED EQUAL DIVISIONS BY THE LARGE POINTERS ON THE LEFT AND RIGHT DECOMETER DIALS

FIGURE 1.—DECCA LATTICED CHART

In the illustration the readings of 156 in the windows of the Left Decometer and 0.45 on the outer dial give the position of 156.45 between lanes 150 and 160 for the broken system of lines. Similarly, readings on the Right Decometer give a position of 673.66 between lanes 670 and 680 for the solid system of lines. The intersection of these two lines of position gives the position of the vessel.

The indicator for this system is a pair of meters which resemble gas meters in appearance. The meters are illustrated in the figure. The small dials indicate the lane numbers, while the larger dials indicate the vessel's position within the lane. It will be noted that the large dial is capable of dividing each lane into 100 parts. In the case illustrated, the lane width is about three-quarters of a mile, which makes the smallest reading on the dial about 0.007 of a mile.

The accuracy of Decca is not the same throughout its useful area. As the spacing between lines becomes greater, the accuracy becomes less. The accuracy also diminishes as the length of base line between master and slave is decreased. For a typical system, at a distance of 30 miles, an accuracy of plus or minus 10 yards can be expected. Ranges up to 300 miles are obtainable in the daytime; the reliable range diminishes to about 100 miles at night.

Tests made by the British Hydrographic Office indicate that the Decca system is suitable for both inshore and offshore hydrographic surveying. This summer the British expect to make surveys in the Thames Estuary, on a scale of 1:25,000, using the Decca stations which have been established for navigational purposes. Future programs call for the use of a portable Decca system which can be set up in any region where surveys are needed.

The possible advantages of this system for hydrographic surveying are:

1. Any number of surveying units can use the system at the same time without fear of saturation.
2. The high degree of accuracy and extreme portability of the mobile unit make it practical for small-boat inshore surveys.
3. Offshore surveys can be made with a considerable degree of accuracy.
4. It is not necessary to elevate the base stations or locate them near the beach, as is most often required of high frequency systems.

Decca shows considerable promise as a means of control for aerial photographic mapping. Its accuracy for such purpose is quite good and the method has the advantage over other electronic systems of comparable accuracy in that the plane can fix its position when it is flying at low altitudes and is a great distance from base stations.

Tests have been made using Decca as a distance measuring system. This was done by having a plane, which carried a receiving unit, fly a loop around the master station and one of the slave stations. A count was made on the plane of the number of lanes passed through; then by proper computation, the distance between master and slave could be found.

Radar for Hydrographic Surveying

The British are also conducting tests with Radar for hydrographic surveying. Their method consists in locating a string of buoys from shore positions. The buoys are equipped with Radar reflector targets. The survey ship is equipped with a precise fire-controlled Radar, which is capable of giving a range accuracy of plus or minus 15 yards. The operation consists in measuring the range to three buoys in rapid succession, and then plotting the position of the vessel by means of a special three-arm protractor. Allowance must be made for the ship's run during the time required to make the range measurements to the three buoys. The maximum range that can be expected is 15,000 yards. To carry the survey farther offshore, a new string of buoys, approximately parallel with the first, are located by means of Radar fixes. The survey is then continued in the same manner as with the first string of buoys.

Marine Charts for Electronic Navigation

Considerable attention was given at the conference to a discussion of the best method of altering or modifying the nautical chart to make it of maximum use for Radar in coastal and harbor navigation. The opinion was expressed by some of the delegates that the chart will have to be modified, but it is too early to predict accurately just what these changes will be. The view was expressed that there will be regions where topographic features need be added to the chart. A few such experimental charts have been reproduced in this country and in Great Britain.

On U. S. Coast and Geodetic Survey chart No. 6102, Approaches to Strait of

Juan de Fuca, gradient tints in brown have been applied to bring out the relief and the features which might appear on the Radar screen. If these charts prove useful, it may be necessary to pay more attention to topographic mapping, especially in the coastal regions. However, there was considerable belief that the source material used in compiling the Radar chart would probably come from a Radar survey, made with instruments which are similar to the types used by the mariner for navigation.

Attention was also given to grid or latticed charts, which are used in conjunction with such radio navigating systems as Loran, Decca, and Gee. With the conversion of these systems from war to peacetime use, it is natural that the charts used by these systems will likewise undergo some conversion. In the case of Loran, special charts were made that were useful only to this type of navigation. This required the navigator to have a number of these special charts in addition to his usually large list of standard charts. While this was a justifiable war measure, the mariner is now registering complaints by reason of additional expense and the inconvenience of extra charts. The obvious solution seems to be to combine these two charts, but by so doing there is always the danger of diminishing the usefulness of the standard chart by the addition of grids, especially in congested areas. It was believed that considerable thought would have to be given to this problem before a workable solution could be reached. Such a solution should be considered on an international basis because of the world-wide use of nautical charts.

(EDITOR'S NOTE.—The U. S. Coast and Geodetic Survey has issued an experimental Loran chart in which Loran curves are printed in color on the reverse side of the regular navigational chart in exact registry with the face. A plotted Loran position can be pricked through the paper giving the vessel's position in relation to the charted detail.)

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Microwave Beacon to Guide Ships From Lighthouse

THE familiar lighthouses that mark American coasts may soon send out invisible radio signals to guide ships at sea, as well as the present visible flashing light. A new electronic beacon for the purpose has been revealed by General Electric.

Microwave beacons they should be called, because they use this exceedingly short wave which, like radar pulses, travels unhindered through fog, rain, snow, and sleet. A unit, built for the U. S. Coast Guard, will be tested early in May at New London, Conn. Its signals will be receivable only on radar-equipped vessels. The signals will appear as a bright ray on the ship's radar indicator, showing the exact direction of the beacon in the same way that the lighthouse is located by its beam of light.

The beacon equipment consists of two main units, the transmitter and antenna. It beams the radar waves in all directions from a vertical dipole antenna that resembles a policeman's night-stick in shape. One light house tube powers the unit. The beams are in the 3200 megacycle range.—*Science News Letter*, May 3, 1947.

A Plan for Improving Surveying and Mapping in Ohio

By MYRON T. JONES* *and* OSCAR J. MARSHALL†

COMPLETE and accurate maps of an area are the first important requirements for the planning of any engineering project. Such information is basic, and any incorrect data can be the source of much trouble and expense later. A plan is presented here for a workable organization to collect and distribute surveying and mapping information. The objective of such an organization would be to make reliable and detailed survey data available to all who may need it.

Almost everyone has need for accurate map information at some time. The following are a few of the organizations or agencies which are constantly and vitally concerned: U. S. Coast and Geodetic Survey, U. S. Geological Survey, U. S. Army Engineers, Agricultural Adjustment Agency, and Soil Conservation Service; various state organizations such as highway departments, departments of public works, conservation districts, and drainage districts; county and city engineers, railroads, utility companies, abstract companies, engineers, surveyors, architects, and others too numerous to mention.

Today we have many organizations collecting data and preparing maps. The two most prominent and authoritative are the U. S. Coast and Geodetic Survey and the U. S. Geological Survey. The former makes charts of the coastal waters and air navigation charts, and provides the most accurate vertical and horizontal control for the making of maps. The latter has made topographic maps of about one quarter of the country, including Ohio. The present quadrangle maps of Ohio have saved many thousands of dollars and have been a great benefit to engineers in preliminary planning.

The Army Engineers have made thorough surveys in areas concerned with flood control and war planning. The Agricultural Adjustment Administration has spent thousands of dollars in establishing ground control for aerial mapping. This consisted of tape or odometer measurements along roads for the purpose of checking the scale of photographs, in counties where there was only partial or no information available for this purpose. Most public utility companies maintain a special department for surveys and mapping in the territory covered by their operations. Cincinnati, Toledo, Columbus, and Cleveland have made or are making precise surveys for the purpose of establishing vertical and horizontal control for mapping and other purposes. Cleveland started work several years ago on a map of underground utilities which will show the accurate location of all facilities on one set of master maps. Many mining, railroad, municipal, county, and consulting engineers and surveyors have made accurate surveys of areas in which their work called for such information.

The Ohio State Coordinate System

The need is, therefore, apparent for a system of surveys and an agency to collect, co-ordinate, and furnish the latest available information for the use of

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all concerned. A step towards the proper system for the horizontal control of all maps was taken when the Ohio State Legislature adopted the Ohio Coordinate System in 1945.

The purpose of the State Coordinate Systems is to make available to land surveyors and engineers the thousands of monumented points throughout the country established by the U. S. Coast and Geodetic Survey during the past hundred years. The Systems provide a means for the scientific location and description of land boundaries by the *usual methods and formulas of plane surveying.*

The preamble of the act legalizing the use of the State Coordinates in Ohio gives as its purpose: "To describe, define, and officially adopt a system of coordinates for designating and stating the positions of points on the surface of the earth within the State of Ohio."

The effect of the legislation will be to:

(*a*) establish the legal status of the State System;

(*b*) insure uniformity and definiteness in terms used;

(*c*) impose reasonable standards in the use of the Systems when the State Coordinates are to become part of the public records.

The legislation provides that the use of the State Coordinate System shall be permissive, not mandatory. Used as bases for control surveys, the State System will effect a tremendous saving in time and money in preparing specifications for and putting into effect many postwar plans relating to urban and rural land development, in the extension of private business facilities, and in public works construction. It provides a simple control to insure a proper use of those Systems.

The extent to which the Ohio Coordinate System can be used for property description, now or in the early future, is still limited. Control stations, with coordinates determined, are available within reach of only a small part of the total area of land to be described. The use of the Coordinate System will become possible in all areas of the State as the national, state, and local survey organizations continue to fill the gaps. In the meantime, we have in Ohio an act defining and naming a system for the State which will insure, from the very beginning, uniformity of terminology and certainty of the meaning of the terms used. It will also impose reasonable standards for, and limitations upon, the use of coordinates for descriptions of boundaries when those descriptions are to become a part of the public records.

A State Bureau of Maps and Surveys

In order to promote the purposes of this bill and provide a central agency where anyone may obtain all available information, it is necessary that the State of Ohio establish a Bureau of Maps and Surveys. The functions of such a bureau should include the following:

1. Gather and permanently file copies of all maps of the State or portions thereof which may be expected to be of use to the bureau in its work, or of value for reference to other agencies or the interested public.

2. Collect and permanently file records of all monumented points which have been established and which may be established to form the state-wide survey control system. This shall include data relative to both horizontal and vertical control.

3. Acquaint the many agencies, both public and private, doing surveying and mapping work within the State, with the presence of and the uses that may be made of the

information on file and the advantages which accrue to the public through the use of the state-wide control system.

4. Furnish information in regard to control monuments recorded in the files upon request and supply copies of available maps to interested agencies or individuals at the cost of reproduction.

5. Prepare, adopt, and promote the use of standard specifications for surveying and mapping of various classes.

6. Serve to co-ordinate the efforts of the many agencies, federal, state, county, city, and private, making surveys and maps within the State in order to avoid duplication of effort.

7. Expand or elaborate the federal survey control systems to the end that the frequency and accessibility of control points throughout the State will ultimately be closely related to expected relative needs in areas of different population and land-value classes.

8. Establish and maintain control survey points determined by the personnel of the bureau or derived from other surveys made to a standard satisfactory for their inclusion in the Ohio Coordinate System or the network of levels referred to the U. S. Coast and Geodetic Survey datum.

9. Foster and assist in the training of selected members of other qualified agencies which may desire to co-operate with and supplement the work of the bureau in the course of the normal work of those agencies.

Map users in Ohio are finding the existing U. S. Geological Survey topographic sheets increasingly inadequate because the scale is too small or the maps are out of date. Demands for better maps may soon lead to one or more extensive mapping projects in Ohio. It is very desirable that the State bureau, herein proposed, be set up soon enough to provide necessary control data on a basis which will serve many other purposes, as well as that of control for state-wide maps—thus avoiding duplicate surveys and additional expense.

It will cost money to establish the control for the Coordinate System and it will be necessary that the State Legislature allot funds for the work. Likewise, it will be necessary for an act to be passed creating the Bureau of Surveys and Maps which might well come under the Department of Public Works.

The law which was passed in 1945 is a step in the right direction, but it was enabling legislation only, making the State Coordinate System legal. No agency was created to make it function and no funds were appropriated to establish the co-ordinated control.

The support of all interested agencies and persons is needed to obtain proper action on both matters. The authors will welcome comments, criticisms, and suggestions from all interested parties.

* * *

"Injuns" and Surveyors

THERE is a Western yarn of some Indians who were observed going through an inexplicable performance out on the prairie. They would get in a huddle, all gazing in one direction, one stooping a little, shading his eyes with his hand, then waving his arms; one or two would walk ahead; they would gesticulate and shout; then the rest would come up, and repeat the performance. The onlookers were completely baffled, and it took considerable investigation to discover that the Injuns were imitating a survey party! They didn't know what the purpose of a survey crew might be, or what it accomplished, but they thought it must be making medicine, so they went through the motions faithfully.—*The New York Herald Tribune,* March 17, 1946.

Museum of Surveying Equipment

By CHARLES R. MANOR
TOPOGRAPHIC ENGINEER, THE ENGINEER BOARD

A MUSEUM of surveying equipment, perhaps the most complete and certainly the most up-to-date of its kind in the world, has been established at the Engineer Board, the Corps of Engineers' research and development organization at Fort Belvoir, Virginia.

The instruments on display include the latest and the best. Some are those used by the United States Army in World War II. Some experimental models are in the collection, and others are enemy instruments captured in the various theaters of the war and sent to this country for testing and evaluation.

More than half of the enemy items on exhibit were obtained by Engineer Intelligence units before the end of hostilities, and were found by troops in most cases one by one rather than in large numbers. The rest were sent after the war ended. Some are still being received.

The museum was set up under the direction of Lieut. Col. W. C. Cude, director of one of the five divisions into which the Engineer Board is divided, and Mr. M. C. Shetler, head of the division's Ground Control Branch, by order of Col. James C. Marshall, Engineer Board President.

The Ground Control Branch is charged with adapting, as far as possible, commercial items of survey equipment for military use, and with developing and testing new equipment and methods of surveying. The evaluating of foreign instruments being a part of the latter function, the museum is not merely a "dead" collection but an organized "working basis" for technicians who regard each item as a possible source of ideas for the improvement in design of instruments for Army Engineers.

The museum includes a sample of almost every known type of foreign equipment, a fact which is indicated by a check of the instruments on hand with captured foreign catalogues and other information.

Preliminary study of the Japanese instruments indicates that they will be of little or no value. In most cases they are poor copies of American or German equipment. On the other hand, the European instruments may be the source of numerous ideas for improvements. Experts who have examined them describe them as fine instruments in which many advanced developments are incorporated.

Manufacturers of surveying instruments and the civilians who use them on thousands of jobs throughout the nation will benefit from the study being undertaken by the Engineer Board's staff of scientists, for the military objective and the civilian one are the same—to develop instruments which are more accurate and which get the job done faster and easier.

It is impossible to estimate the total value of all the equipment in this "working museum," but it approximates several hundred thousand dollars. Some of the instruments are the only ones of their kind known to be in existence, and others were produced in laboratories which now are rubble.

Reprinted through the courtesy of *The Military Engineer,* November 1946. This paper is a condensation of the paper presented by the author at the Sixth Annual Meeting of the American Congress on Surveying and Mapping, Washington, D. C., June 28–29, 1946.

Some of the instruments in the museum are pictured in the accompanying illustrations.

Foreign Instruments

How the Japanese copied designs is illustrated in figure 1. The theodolite on the left and the small one on the tripod in the center are Japanese. When compared with the Hildebrand (German) theodolite on the right it will be noted that many minute details are identical, down to fixtures and accessories in the carrying cases.

Figure 1.—Comparison of Japanese theodolite with German instrument.

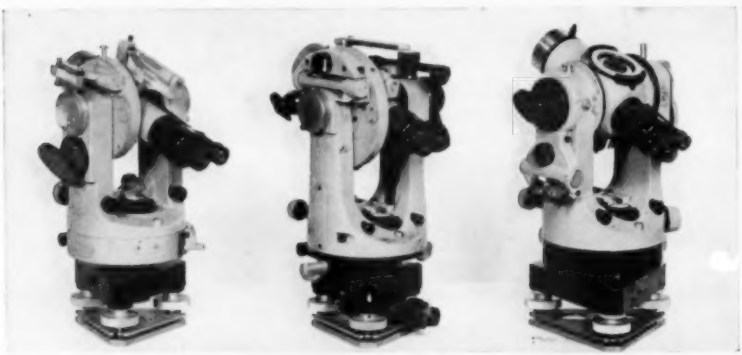

Figure 2.—Standard Zeiss theodolites.

The standard models of Zeiss (German) theodolites are shown in figure 2. Model III in the center is very similar to Model IV on the left except that a micrometer on top of the standard allows finer readings to be made on the horizontal circle. Model II is the standard 1-second theodolite and is a fine instrument.

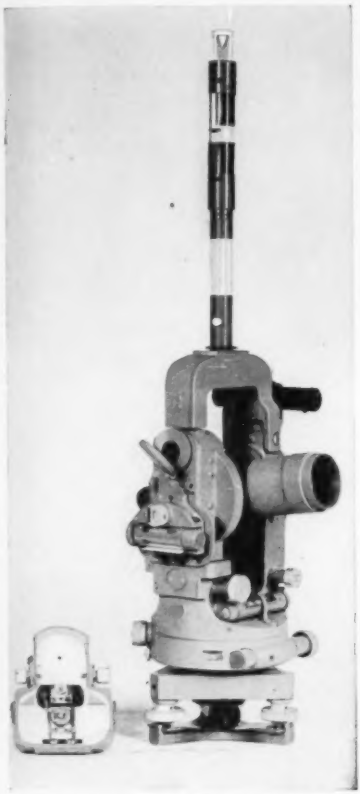

FIGURE 3.—Zeiss Theodolite 40.

Figure 3 is known as the Zeiss Theodolite 40 and is the standard German Army theodolite. This is really a universal theodolite with complete night lighting, fine black-out of the artificial lighting, a built-in sunshade arrangement, a detachable coincidence-type compass, and an optical plummet. The housing on the left is the lighting attachment which fits over the light opening and the control level.

Two of the Swiss theodolites are shown in figure 4. They employ a unique method of leveling by cams. The initial leveling is done by a tripod head which is clamped rigidly in place at three points.

Figure 5 shows three types of double-center optical-reading theodolites. On the left is a Swiss instrument, the center one is British, and on the right is a German type. This kind of optical reading instrument might well be the one that will become most popular in the United States, as it operates more like the American transit.

In figure 6 examples of foreign alidades are illustrated. At the extreme left is a Japanese alidade which has a wooden rule and very small telescope. In the extreme right is an Italian type which has an interesting feature which enables its user to cross-level the pedestal by a screw. A Swiss instrument is shown left center. The housing suspended below the eyepiece is

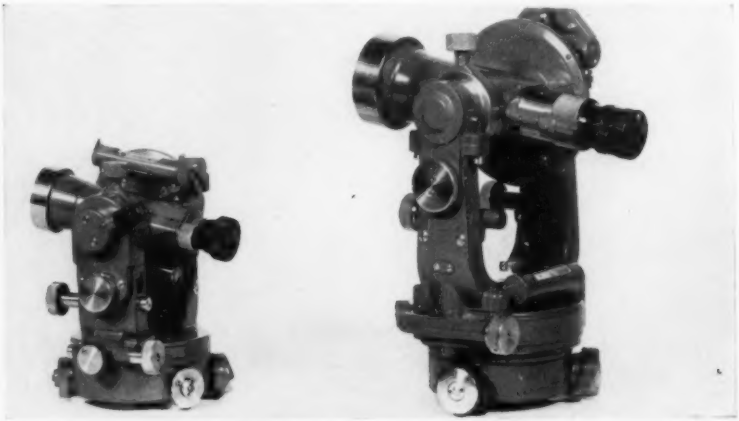

FIGURE 4.—Kern theodolites.

FIGURE 5.—Three types of double-center optical-reading theodolites.

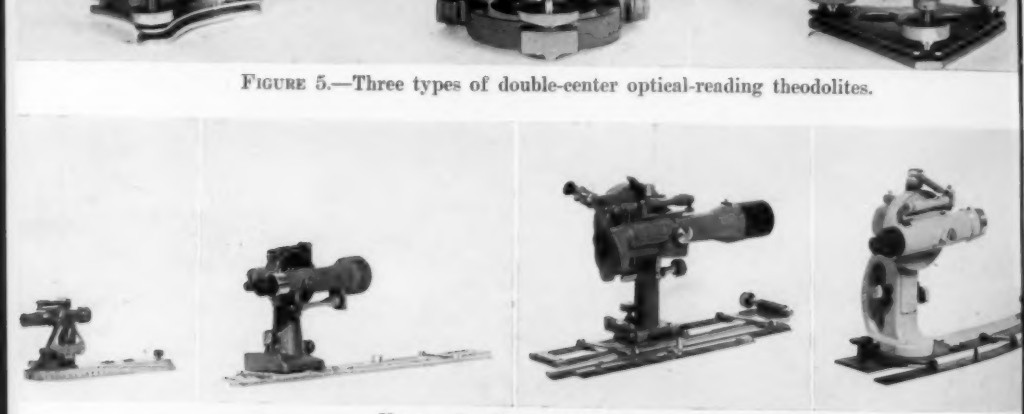

FIGURE 6.—Types of foreign alidades.

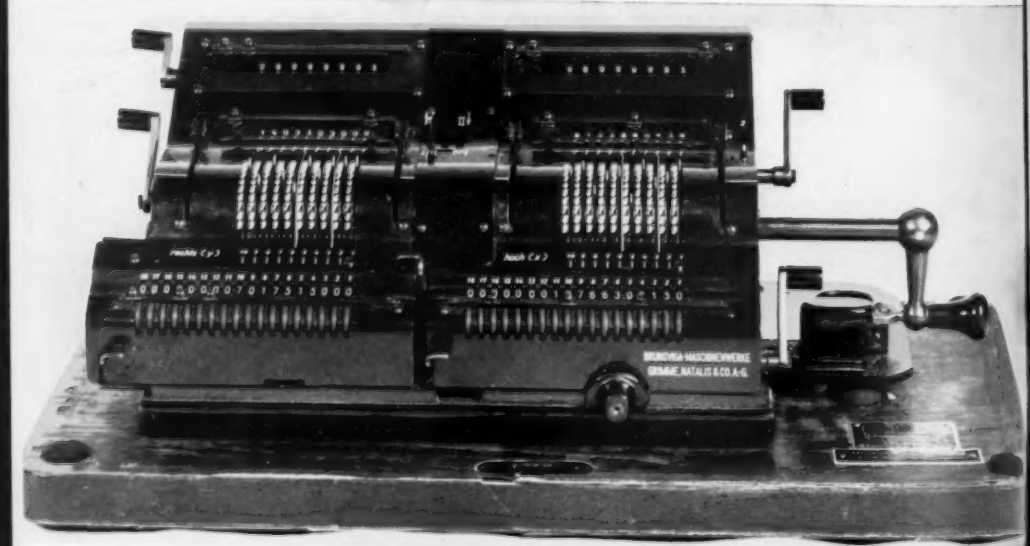

FIGURE 7.—German mechanical survey computer.

a glass reticle which is rotated by a gear hook-up from the telescope axis. Right center is a German alidade which is light in weight, and has a fine handle and good balance.

A German mechanical survey computer is pictured in figure 7. In using it the starting x and y coordinates are placed in the two dials at the bottom of the machine. The sine and cosine of the angle are set by pulling down the little prongs in the center of the computer. The value set in may be checked on the dial directly above. After deciding which quadrant the course is in, the operator throws the little lever in the center of the machine between the sine and cosine dials. The arrow for this quadrant then indicates the direction in which the big crank on the far right must be rotated as the distance is turned into the upper dial. The x and y values are added or subtracted according to the proper quadrant, and the coordinates of the new point may be read directly from the lower dials.

The interchangeability feature of the German surveying equipment is demonstrated in figure 8. In the lower center is the standard German tripod. At the extreme left is the tribrach or leveling head complete with base plate, optical plummet, and "bull's-eye" level. This attaches directly to the tripod head by a standard screw arranged so that the head may be shifted. This theodolite has a stub at its base like those on the signal lamps just to the left. The instrument is clamped into the tribrach by the small screw seen on the side of the tribrach. This arrangement allows complete interchangeability of the following items on the tribrach: (1) on left center is a small signal lamp, (2) next to the theodolite a large signal lamp, (3) above and to the left the subtense head, (4) at upper right a target, and (5) the theodolite. This arrangement speeds up surveying operations in many instances. On the right are some additional items which are used on the same tripod but have their own tribrach. Next to the theodolite is the level. Next is a planetable head. On the end is the tribrach which is a part of a chaining kit. Directly beneath the tripod is a telescoping plumbing rod that is

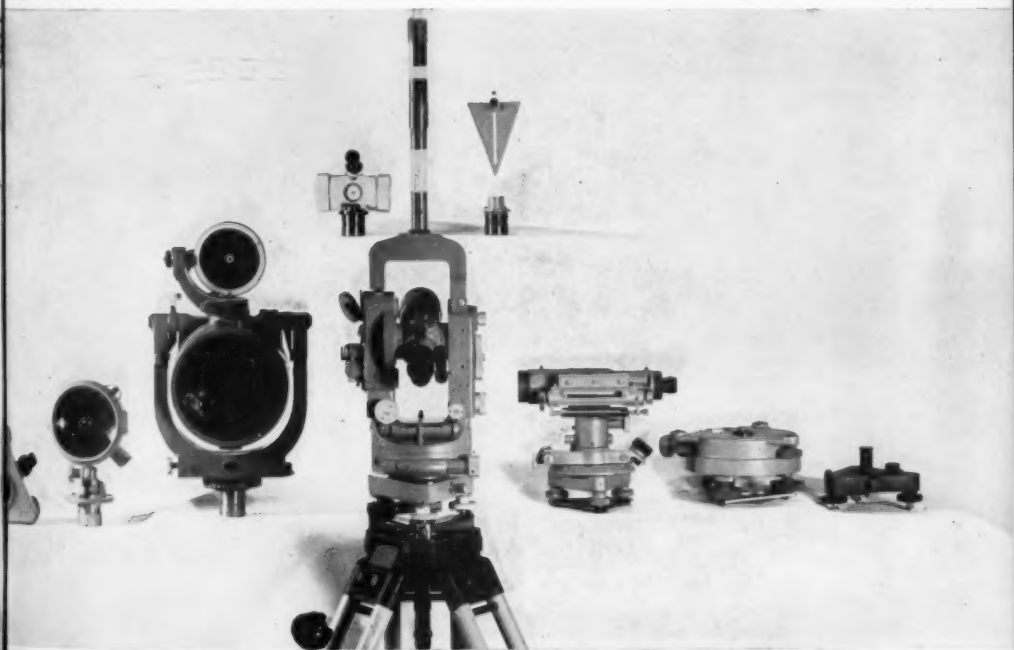

FIGURE 8.—German surveying equipment showing interchangeability feature.

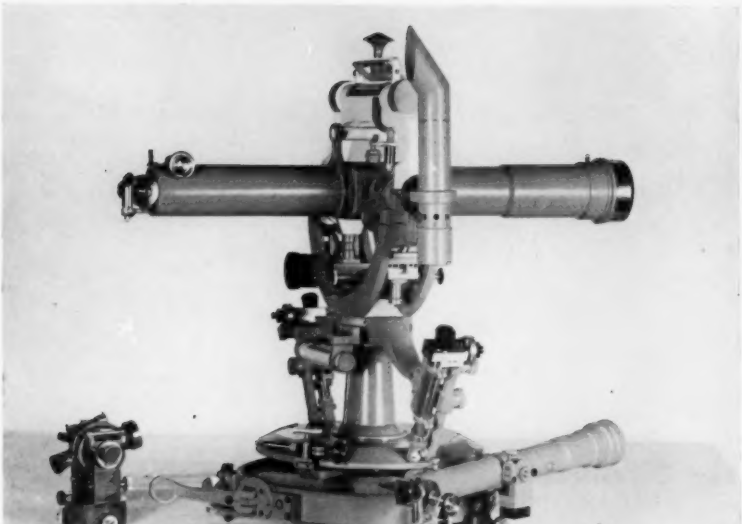

FIGURE 9.—Largest and smallest theodolites.

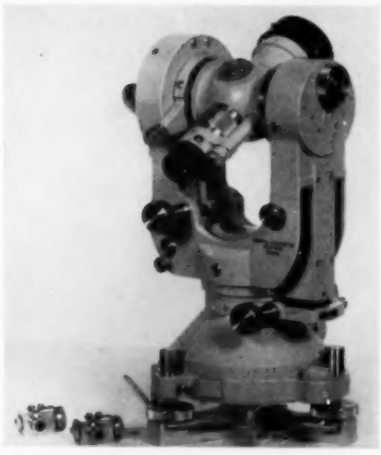

FIGURE 10.—Keuffel & Esser military theodolite.

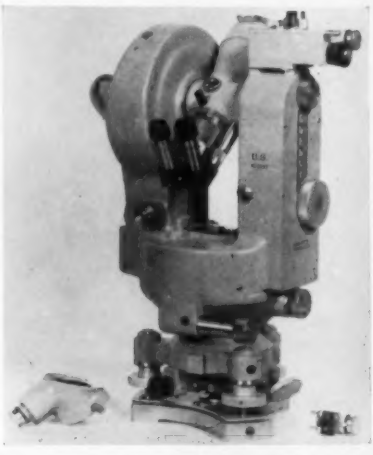

FIGURE 11.—W. & L. E. Gurley military theodolite.

graduated for determining H.I. The instrument is shifted until the rod is plumb as indicated by the "bull's-eye" level.

The largest and smallest theodolites in the museum are pictured in figure 9. The one on the left is a Swiss instrument reading directly to 10 seconds. The one

on the right is a German 1-second instrument. The Swiss theodolite weighs 4 pounds and the German 89 pounds.

Domestic Instruments

Early in the war the supply of foreign theodolites was entirely cut off and the Engineer Board worked with American manufacturers to develop instruments suitable for the Army. Figure 10 is a 1-second optical-reading theodolite built by Keuffel & Esser. It has glass circles and is quite similar in design to the German Wild T–2, and is of comparable accuracy and weight. Keuffel & Esser also developed a 1-minute transit and a 20-second transit equipped with night lighting for military use.

Figure 11 is a 1-second optical-reading theodolite developed by W. & L. E. Gurley, under circumstances similar to the Keuffel & Esser model. These theodolites have stainless steel circles, and are equipped with a coincidence-type cross level on top of the right standard for determining the tilt of the vertical axis in astronomic work. The amount of tilt is read directly in seconds of arc on the graduated drum on the right. The instrument is also equipped for night observing. Limited field tests indicate that this theodolite will do first-order work although it was designed as a second-order instrument. Night lighting accessories were also built for the 1-minute and 20-second Gurley transits.

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Electronic Weather Forecast

Control of hurricanes, prevention of killing frosts, and precipitation of rain in dry areas are possibilities of an electronic weather forecaster now in its early stage of development, Dr. V. K. Zworykin, director of electronic research, RCA Laboratories, Princeton, N. J., told a joint meeting of the American Meteorological Society and the Institute of Aeronautical Sciences at the Hotel Astor in New York.

The principles of an electronic computer now being developed at RCA Laboratories, with the cooperation of Dr. John Von Neuman of the Institute for Advanced Study at Princeton, N. J., Dr. Zworykin said, can be used in the construction of an electronic forecaster. This would enable the making of reliable weather forecasts for days ahead in a matter of minutes. But even more important, Dr. Zworykin pointed out, may be its application in the control of weather, not over vast areas but in modifying such local conditions as dangerous storms, droughts, frosts, and fogs.—*Army and Navy Journal*, February 8, 1947.

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"If all our misfortunes were laid in one common heap, whence every one must take an equal portion, most people would be content to take their own and depart."

—Socrates

Topographic Surveys

Progress Report of the Committee of the Surveying and Mapping Division on Topographic Surveys

EDITOR'S NOTE.—This report was prepared by a committee of the Surveying and Mapping Division of the American Society of Civil Engineers and appeared in the *Proceedings, American Society of Civil Engineers* for April 1946. It is being reprinted in SURVEYING AND MAPPING in two installments. The first installment deals with factors to be considered for a proposed topographic survey. The second—the Appendix—contains recommended specifications and will be published in a later issue of SURVEYING AND MAPPING.

The report is intended primarily for the guidance of private-practice engineers and surveyors who may be engaged in making topographic surveys and maps for engineering and architectural projects. The report does not recommend any changes in the widely accepted national map-accuracy specifications for the standard topographic maps produced by agencies of the Federal Government.

Comments and constructive criticisms from practicing members of the Congress are solicited.

I. PURPOSE AND SCOPE OF THE REPORT

This report is presented in the desire that it may be helpful to topographic engineers in their effort to render the maximum of service to their clients, and to assist engineers engaged in design and construction to judge the adequacy of the map to serve as a basis for their work.

The committee hopes that the report will tend to raise the standards of topographic surveying and will help engineers to appreciate the fact that topographic mapping is a type of service that requires special training and that offers opportunity for the display of skill and imagination in the improvement of the quality of the service. Topographic mapping methods are not static.

Attention is focused herein on some aspects of topographic surveying which are often overlooked by many persons undertaking such work. The topics discussed are general, such as classification of maps, the selection of map scales and contour intervals, methods of developing topographic maps (with characteristics of each), the planning of the survey, and writing specifications.

In appreciation of the fact that many excellent textbooks and Federal Government bulletins treat, in detail, the description, care, and manipulation of survey instruments and their accuracy, this report does not attempt to invade this field, but refers the reader to his favorite textbook.

The function of a topographic map is that of a tool fashioned by the topographic engineer to serve: the planning engineer or architect as a basis for the project design; and the construction engineer by facilitating his work of translating the planners' paper plan to the ground, for construction purposes. If the topographic engineer is to fashion a tool that will serve these men adequately, he must have sufficient knowledge of both design and construction to plan and produce the map that will exhibit all pertinent data.

II. CLASSIFICATION OF TOPOGRAPHIC MAPS

Topographic maps may be classified under three general headings or types dependent upon their use and map scales:

1. *Small-scale information maps.*—Large areas are mapped at map scales varying from 1 inch equals 2000 feet to 1 inch equals 1 mile, approximately, as illustrated by the map sheets of the U. S. Geological Survey, the Tennessee Valley Authority, and the U. S. Corps of Engineers. The procedure for preparing for these maps is well standardized (refer to the topographic instructions issued by these agencies).

2. *General topographic maps (reconnaissance).*—For generalized studies, decisions as to suitability of areas, preliminary location of highways and utilities, approximate estimates of costs, and the determination of those areas to be included in detailed topographic maps, map scales will vary from 1 inch equals 400 feet to 1 inch equals 1000 feet.

The entire area available for the project should be included in the general topographic map except those parts which inspection indicates to be unsuited for any present project use.

3. *Detailed precision topographic surveys.*—For detailed studies and plans and for estimates of cost, map scales vary from 1 inch equals 20 feet to 1 inch equals 200 feet.

Only those parts of the area, general studies of which indicate a probability of use and for which use detailed plans will have to be made, are recorded in detailed topographic maps. Such detailed maps will cost from two to five times as much per unit area as will the general topographic map.

To be considered acceptable from an accuracy standpoint, maps should fulfil the conditions stated in the Appendix. Maps complying with standards stated under Section C should be classed as of first-order accuracy and so designated by a marginal note on the map.

The purpose of many reconnaissance topographic surveys is such that first-order accuracy is not required or desirable. Since, often, for general studies, errors in position of 10 feet or 15 feet are in no way harmful; and, since in the same way errors of 10 feet in elevation do not affect the general plan, the specifications should be modified correspondingly. Maps of this type should be designated as of second-order accuracy and should carry a marginal note specifying the designation.

III. SELECTION OF MAP SCALES

The character of proposed developments, for which topographic maps may be made, has as many variations as there are activities in the field of human endeavor. The importance of the selection of the proper map scale cannot be overstated. The kind of project and the kind of use for the survey and map information will determine, to a great extent, the scales to which each map should be drawn. It is essential that careful consideration be given to this part of the problem in order that economy in time and in the cost of production may be effected. When analyzing this problem, the engineers must always keep in mind questions of clarity, accuracy, cost, facility of correlation, and the physical factors that affect the choice of a map scale.

Clarity.—Facility with which the data can be interpreted is a ruling consideration for clarity. Obviously, map value is lost if it is so cluttered with symbols that the important data do not "stand out" clearly. The user "can't see the woods for the trees."

Accuracy.—The interrelationship between map scale and map accuracy must be kept in mind constantly. Obviously, it is absurd to demand, in the location of a mapped point, that its position is to be correct to 0.1 foot when, because of the map scale, 2 feet is the minimum distance the eye can plot. When the scale is fixed, the limit of accuracy for the map is also fixed. Conversely, if the tolerance of accumulated error for a map is fixed, a limit is placed on the map scale, at the same time.

Cost.—The cost of a topographic survey increases rapidly with increase of map scale, because of increased amount of detail that can be shown with clarity and because of the increase in the accuracy requirement for each of the survey operations that comprise the finished product.

Facility of correlation.—To facilitate the correlation of data contained in the different project maps, the topographic map, as well as all other project maps, should be either on the same scale or, if this is not feasible, on scales which are even multiples.

Physical factors that affect the choice of a map scale.—Three factors influence the selection of a map scale: (1) The number and character of cultural features that are to be shown and the frequency of their occurrence; (2) the nature of the terrain, steepness of slope, and the intricacy of the topographic detail; and (3) the contour interval necessary to depict the topographic detail adequately. Field inspection and study of these factors will pay dividends.

IV. SPOT ELEVATIONS

Contours often cannot record the complete story. Elevations of summits, tops of banks, bottoms of depressions, bridges, and road and railroad intersections should be given in numerals. These are known as "spot elevations."

V. MAPS REQUIRING TWO CONTOUR INTERVALS

Where the area to be mapped includes areas having two very different types of slope, it is often desirable to use a different contour interval on the flatter areas. To use the same contour symbol for contours having different intervals destroys a correct visual interpretation of the change in slope. It is recommended in such instances that the one adopted contour interval for the map be used over the entire map and that, on the flat areas, in addition to the regular contour, a dotted contour line representing the one-half contour interval be located and drawn on the map.

VI. MAP TESTS AND WRITTEN SPECIFICATIONS

The planning department of an engineering organization always demands speed—and more speed—from the survey department. No matter how great is this demand for speed, the engineer should never be tempted to start field parties before writing a complete set of specifications for each of the survey operations that enter into the construction of the completed map. Field tests should be run on each map sheet immediately after field mapping is completed. Both these precautions will pay dividends in economy of time and cost before the job is completed. It is to be remembered that the completion date is the important date—not the commencement date. The map must be a homogeneous product, trustworthy in all its parts. This cannot be accomplished if each party chief is left to his concept of his part of the work. Each party chief must have definite written specifications covering his part of the field work since each one will interpret the written work differently. Therefore, it is necessary that there be close supervision of the field work by the topographic engineer in charge. Map tests will show that some men are too meticulous and waste too much time in accomplishing a higher degree of accuracy than that necessary, whereas others will be too careless and so vitiate the final product. Field inspection and field tests are necessary to reduce these considerations to a common denominator.

VII. METHOD OF DEVELOPING TOPOGRAPHIC MAPS

The intent herein is to present a brief outline of methods in common use and

to present their characteristics. For details concerning instruments and methods of operation, the reader is referred to textbooks on surveying and on photogrammetry.

Systems of horizontal and vertical control established by ground surveys form the foundations or skeletons for the construction of topographic maps, regardless of the method of filling in the topographic information that transforms these skeletons into vital maps. Filling in topographic detail may be accomplished by:

a. Planetable method (entirely ground method).
b. Combination use of planetable and vertical aerial photographs.
c. Stereophotogrammetric methods based on the use of overlapping vertical photographs and stereoscopic plotting instruments of various types.
d. Transit-stadia method (entirely ground method).

Study should be made of the specific conditions prevailing on each job before a decision is made as to the method that is to be used. Some one method is better suited to a particular set of conditions. No one method is a topographic cure-all, surpassing all others under all conditions.

a. Planetable method.—In the planetable method, the control data are platted on map sheets (usually 24 inches by 31 inches) the size of the planetable boards. These are then sent to the field where the topographic information is obtained and platted on them. Direction is determined by pointing the telescopic alidade at the object or the rod. This direction is translated to the paper by drawing a penciled line along the edge of a fixed ruler attached at the base of the alidade. Distance is obtained either by stadia or by chaining, depending on the requirement of the map scale. Elevations are determined either by direct or by trigonometric leveling, using the alidade for this purpose. The located points, with their elevations, are platted on the map immediately; and the contours and other topographic features are drawn in while the topographer looks at the features to be expressed. The principal characteristics of the method are:

(1) Fidelity of topographic expression.
(2) Economy of the number of located points necessary to maintain a stated standard of accuracy.
(3) Elimination of office computation, interpretation, and platting of copious sets of notes sent by the field men to the office; and the elimination of opportunity for error in the plotting of data from the notes made by another person.
(4) Visual inspection of the map and of the ground, thus showing the topographer just where the next rod is needed to develop the map properly, and thereby insuring lack of duplication and lack of necessary rodded points.
(5) Immediate detection of errors that may have been made, and immediate opportunity to search for, and correct, the error. Planetable traverses for the location of data are run in closed circuits, originating from, and closing upon, control points already platted on the sheet. The error of closure of the platted planetable traverse indicates whether the error is greater than the tolerance stated in the specification.
(6) Successful use at any map scale for areas of any magnitude or on any character of terrain.

There are conditions under which the planetable method will not be as economical in time or cost as would some other method.

b. Combination use of planetable and aerial photographs.—In this method overlapping vertical photographs are obtained. The position of the ground control points are identified on the photographic prints. By comparison with the plotted position of these

control points, the photographs are brought to correct map scale. The photographic data are then transferred, photographically, and in nonphotographic blue, to the planetable sheets. Correct position of the transferred information is attained through the use of the horizontal control which has been previously platted on the planetable sheets. The planetable map sheets must be mounted on aluminum or zinc, to prevent undue paper distortion during the photographic process of transferring the information from the aerial photographs to the planetable sheets. The transfer process is a wet process. The planetable sheets are then sent to the field for the location of the contours by the planetable process. The topographer at the same time proofreads the sheets for any misinterpretation of the planimetry which was transferred from the photographs. He pencils on the blueline transfer, all data which are to appear on the finished map, such as roads and buildings. These map sheets are then returned to the office and the penciled data are inked in black. Since all other data on the sheet are in nonphotographic blue, they disappear in the reproduction process. The principal advantages of the method are:

(1) Fidelity of detail of planimetry and contour expression.

(2) Reduction of the number of rod readings necessary. Since all planimetry is already located on the sheet, the only rod readings necessary are those to determine critical elevations necessary to contour location. As compared to the planetable method, the rod-reading time in the field will be reduced by 60 percent, while maintaining the same map accuracy.

(3) Requirement of no expensive equipment, beyond that usually in the possession of topographic engineers.

The method is well suited to the mapping of large areas having gentle relief, such as river valleys, or for flood control and irrigation projects.

A disadvantage of the method is that it is limited to areas where the topographic relief of the area covered by a photograph does not exceed 150 feet if the map scale is 1 inch equals 800 feet.

c. Stereophotogrammetric mapping methods.—The method of filling in topographic detail by the use of stereoscopic plotting instruments requires the possession of costly equipment and of personnel trained in the use of such equipment. It should be attempted only by engineers thoroughly trained in photogrammetery. A few colleges teach photogrammetry and there are three or four excellent textbooks on the subject. Most of the topographic mapping by this method has been done by federal mapping agencies and by two private concerns who have the equipment and trained personnel. If private engineers desire to use the method it would be best to enter into a contract with one of these companies. Definite written specifications covering the map scale and the contour interval and a statement of the required map accuracy should be incorporated into such a contract. Enumeration of the features to be shown in the map should include the coordinate grid lines and the control stations with their designations, bench marks, and spot elevations. The nature of the tests that will be applied should be stated to insure that the map delivered is in compliance with the specifications in the contract. The method is capable of an accuracy suitable for detailed precision surveys only in those areas where the ground surface is visible from the air. Where the ground is obscured by dense brush or timber, or where the surface—although visible—is flat and monotonous in appearance with little or no visible relief, the contour location will be difficult and in most cases faulty.

d. Transit-stadia method.—As indicated in the name, the topographic detail in this method is located by transit-stadia measurements. The information is recorded in field notebooks, the data are computed and platted in the office, and the contours are drawn by interpolation between platted elevation points. In nature, slopes are irregular; they are uniform only for short distances. This method requires many rodded elevation points and very explicit notes if the interpolated contours are to express the topographic detail faithfully.

VIII. HORIZONTAL CONTROL FACTORS DETERMINING THE USE OF DIFFERENT CLASSES

Horizontal control often has two purposes—to control the accuracy of the topographic survey, and to serve as a basis from which to set the stakes for construction. The methods of establishing control are "triangulation" and "transit traverse." Transit traverse is classified according to accuracy into first order, second order, and third order. Decision as to the amount of triangulation and the order of traverse that should be specified for a particular survey depends on: The map scale and the stipulated map accuracy; the extent of the area to be mapped; and the character of the terrain. Decision as to the accuracy of the control cannot be made until the map scale and the map accuracy have been decided. If the tolerance of error in platting is set at 1/50 inch on the map scale and if the map is to be at a scale of 1 inch equals 200 feet, then the permissible accumulated error of traverse would be limited to 4 feet. Should inspection of the area show that the principal traverse circuit will have a length, between existing control monuments, of 15 miles (79,200 feet), the limiting error of 4 feet requires a traverse with a closing error not to exceed 1:19,800 and a first-order traverse should be specified. However, if the terrain is such that triangulation is practicable, and if inspection shows that the probable length of traverse between triangulation stations will not exceed $3\frac{1}{2}$ miles (18,480 feet), a limiting error of 4 feet requires a traverse, the closing error of which does not exceed 1:4,620 and a third-order traverse may be specified.

If the length of the secondary circuits (run between control points of the primary circuit) can be kept to less than 3 miles, they may be of the third-order accuracy; but, if the control is also to serve for construction staking, the traverse must be second order or better.

IX. PERMANENCY OF SURVEY

No surveyor can afford to have his reputation deteriorate with the decay of the wood "hubs" or stakes that he has left behind him. He should give permanence to his work through proper monumentation. Not to do so is as unfair to his client as to himself. It is also unfair to the generation of surveyors that are to follow him.

X. MAP REPRODUCTION

Much of the accuracy of a map may be lost through its manner of reproduction. Why does any engineer expend the time and money to make a map whose limit of accumulated error throughout is 1/50 inch on the map scale, and then lose this accuracy many times over through reproducing it by tracing linen and blueprinting, in which the over-all error may be as much as $\frac{1}{4}$ inch. Tracing linen alone may change scale between morning and night by more than $\frac{1}{10}$ inch.

A film positive, made on low shrinkage film or on glass, at map scale, may be made by photography from any properly penciled map sheet. Prints from these film positives made by the "ozalid" or other dry reproduction processes will be much nearer to exact scale than blueprints from tracings on linen. The cost will be less than preparing the linen tracing. Maps of large and important projects (especially where many copies are needed) should be reproduced by photolithography or by engraving.

XI. MAP SYMBOLS

Standard map symbols have been adopted by the federal bureaus. These symbols should be used by all topographic engineers.

XII. MAP CORRELATION

Facility of correlation of all map data for an area is important to every engineer and to those of future generations. The relationships in position between projects separated by distances (often considered too great to be of moment) are becoming more and more important. The State Plane Coordinate Systems are being legalized by many states. If private engineers will refer positions on their maps to these Systems, the correlation of all maps can be readily effected and much duplication of survey work prevented.

XIII. RECAPITULATION OF GENERAL ANALYSIS

Each topographic survey will present different problems. Each one demands an analysis of the existing conditions that affect survey procedure. This report segregates five premises for discussion:

1. Use determines the permissible error in a map and affects the map scale and contour interval.

2. Having determined the required map accuracy, specifications should be drawn which will permit a map of that accuracy to be produced. Good engineering does not permit the map to be of either higher or lower accuracy.

3. Definite specifications for each component survey operation must be written and a detailed plan must be prepared covering the sequence, the timing, and the number and type of men needed for each survey operation to complete the job at a fixed date. The survey should be so planned that it will be a continuing manufacturing process, each component part of which operates concurrently, producing a steady flow of finished product.

4. Numerous methods of making topographic surveys are in common use. Each method has advantages under certain conditions. No one of these methods is best suited to all conditions.

5. Measures must be utilized to give the survey permanence on the ground and in the office and to make easy the correlation of all project maps, with each other and with those of distant areas.

Respectfully submitted,

Committee on Topographic Surveys,
Surveying and Mapping Division, ASCE

G. Brooks Earnest — W. H. Rayner
T. P. Pendleton — P. H. Underwood
W. N. Brown, *Chairman*

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NEW TOPOGRAPHIC SURVEYING DEVICE

A new topographic surveying device called the "step-writer," which measures distances directly by the leg-motion of the pedestrian, has been developed for U. S. Army Engineers. —*Science News Letter,* August 24, 1946.

Historical Chart Engravings

By ALBERT A. STANLEY

CHIEF, GEOGRAPHIC SECTION, U. S. COAST AND GEODETIC SURVEY

THERE are on file in the Coast and Geodetic Survey a large number of original copperplate engravings of early editions of nautical charts published by the Bureau of the coastal waters of the United States. Many of these engravings reflect the finest technique in past methods of chart reproduction emphasized by the inclusion on the charts of engraved harbor views, etchings of prominent landmarks, and elaborate titles and notes. Although many of the copperplates have been discarded, there still remains a large selection of the more picturesque engravings suitable for framing.

The earliest chart published by the Coast and Geodetic Survey for which copies are available is a sketch of Newark Bay, first published in 1839. The engraving of the chart, which was done on stone, is no longer available, but a photographic negative has been prepared, and prints are reproduced from the negative upon request.

Among the most artistic of the early charts is a series of three reconnaissance surveys of the western coast of the United States on the scale of 1:1,200,000. Chart 601 of the group covers the coastal area from San Francisco to San Diego, and was published in 1853. There are included in the margin of the chart seventeen separate etchings of harbors, headlands, and bays. A most interesting view on the chart is one showing the initial point of boundary between the United States and Mexico. Chart 602, published in 1854, covers the area from San Francisco to Umpquah River, and contains twelve marginal etchings; Chart 603, published in 1855, covers the coastal area from Umpquah River to the Canadian Boundary, and contains eight etchings.

The many harbor charts are especially notable for the greater detail in which the geographic and hydrographic features are portrayed. An outstanding example of this type of early charting is represented in Chart 621 of the Entrance to San Francisco Bay, published in 1859 on the scale of 1:50,000. In addition to the carefully executed terrain and nautical details, there also appear on the chart two excellent examples of etching of panoramic views. Chart 337 of Boston Harbor was published in 1867 on the scale of 1:40,000, and contains inserts of six harbor views. Chart 120, showing New York Bay and Harbor, was published in 1866 on the scale of 1:80,000, and shows the built-up portion of the metropolitan area of New York City.

The coast charts of the 1:80,000 scale series provide coverage of the greater part of the eastern and Gulf coasts of the United States. Charts of this series, ranging in number from Chart 104 to Chart 194, provide many splendid examples of the artistry employed in the production of the early charts. An outstanding chart of this group is Chart 116 of a series of three charts published in 1855 and covering Long Island Sound. Chart 116 is the western sheet of the group, and contains an insert of Lower New York City in addition to six etchings of prominent lighthouses and the adjacent shoreline detail.

Much interest has also been expressed in the efforts and experiences of James McNeill Whistler during his brief employment in the Engraving Section of the

Plate 41 B

U. S. Coast and Geodetic Survey
L. O. Colbert, Director

SKETCHES BY WHISTLER

November, 1854

James McNeill Whistler, at the beginning of his brief employment on the Coast and Geodetic Survey prepared this sample to demonstrate his aptitude for copper plate engraving. These sketches represent the initial results on copper of Whistler's fancy and invention and are the first genuine Whistler etchings.

Coast and Geodetic Survey. Whistler was appointed to a position in the Bureau in November 1854 at the age of twenty, after leaving West Point where he had been a cadet for three years. He left this position in February 1855 after producing two works which had been described as "Coast Survey No. 1" and "Coast Survey No. 2, Anacapa Island" (engraved by J. Whistler, J. Young, and C. A. Knight). The latter, which includes an etching by Whistler of the headland of the eastern extremity of Anacapa Island, has been reproduced as Coast and Geodetic Survey Plate No. 414A, but no record is available of the former.

These two purely professional and official plates are not, however, the first efforts of Whistler as a copperplate engraver in the Coast and Geodetic Survey. Upon his entrance on duty, he received technical instructions in the art of etching and copper engraving, which are reflected in a series of practice sketches. First place should be accorded to the sketches which are the initial results on copper of Whistler's fancy and invention, and the first genuine Whistler etchings. The sketches are in the shape of little heads that intrude on the blank spaces of the copper above and around two neatly engraved views of portions of the coast of the United States in Boston Bay. At intervals, while doing the topographical view, he paused to sketch on the upper part of the plate the vignette of "Mrs. Partington"; "Ike," a soldier's head; a suggestion of a portrait of himself as a Spanish hidalgo; and other bits of interesting work.

The original engraving of this piece of work is no longer available, but a photographic negative from a reproduction of the engraving has been retained. The accompanying illustration is reproduced from the negative on file in the Coast and Geodetic Survey.

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Mississippi River's "Grand Canyon" Discovered

A CANYON 5 miles wide with walls more than 600 feet high has been discovered along the lower Mississippi River by oil prospectors. You can not "see" it without a seismograph for studying the geological structure of the area.

The Mississippi's "Grand Canyon" was described by Walter J. Osterhoudt of the Gulf Research and Development Company.

Geologists have known for some time that there should be a canyon on the lower part of the "Father of Waters," but where it was or what had happened to it was one of the principal unsolved problems of submarine geology.

The answer, discovered by oil prospecting parties in the Mississippi delta region, is that the canyon is still there, but it has been filled in with sand and mud.

The huge canyon, cut by the river within recent geological history, was first spotted by seismograph readings in the region south of Timbalier Bay in Louisiana that revealed a sharp deepening beneath the surface of the delta. This underground structure proved to be the east bank of the missing canyon.

Further tests revealed evidence of the canyon at three other points near the present river channel from Houma, La., to the Gulf of Mexico.

The Mississippi was once so much more powerful than it is today that it could scour the deep channel far below sea level.—*Science News Letter*, May 4, 1946.

Photogrammetry's Contribution to Cartography and Agricultural Problems

By MARSHALL S. WRIGHT*

THE CONTRIBUTION made by the comparatively new science of photogrammetry toward the accumulation and delineation of cartographic information is almost beyond conception. The ability to literally and figuratively "rise above our environment" and obtain photographs of the earth's surface from various elevations, is unquestionably the greatest single development and advance in the long history of cartography. Man is now able to attain the objective he has long desired. By means of an aerial camera he is able to bring back from the sky visual evidence of the gnarled and misshapen face of the earth, and can then conform it to an over-all picture of the terrain.

The theory of photogrammetry alone is of absorbing interest; it leads to problems which attract the mathematician and the surveyor as it also does the thoughtful instrument designer. As a science, however, photogrammetry is dependent almost entirely on a phenomenon of nature, which, from a biological standpoint, has never been satisfactorily explained. I refer to stereoscopy, or the faculty of observing the third dimension. The general principle of stereoscopy is based upon the theory that the two human eyes receive what may be termed surface images of objects in three dimensions; that is, as solid objects. The combination of the two eyes, their optical mechanism, and the brain interprets these impressions in such a way that the well-known perspective and solidity effects are experienced. In stereoscopic photography the two positions of the camera form correspondingly dissimilar images of the same object, and the stereoscope enables the eyes to reconcile these slightly different images so as to produce stereoscopic vision. Since the brain combines or blends these two dissimilar images into a single image the result is that this latter image has the appearance of solidity, or the third dimension.

The practical utilization of aerial photogrammetry in all parts of the world shows that it now forms a very important part in modern survey methods. It also proves, from the standpoint of economy, that mapping by aerial photography is now able to stand the criticism of engineers who but a few years ago were smiling at the idea of being able to make accurate maps from aerial photographs. Reference to economy and accuracy, however, does not exhaust the virtues of aerial surveying; for example, the value of the aerial photograph itself as a permanent record is of paramount importance. It is the very best documentary evidence of the physiographic and cultural condition of a given section of the earth's surface at any one time. Many years, even centuries, later, this condition can be reconstructed from the aerial photograph with extreme and undiminished accuracy.

Photogrammetry in the U. S. Department of Agriculture

The U. S. Department of Agriculture has found many practical uses for photogrammetry in surveying the land and also in studying its natural resources. Few

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people, beside those most directly affected, have much comprehension or any conception of the vast scope and the magnitude of the contribution aerial photography makes toward the fulfillment of the Department's objectives relating to the growing, marketing, and distribution of agricultural products; to the protection and management of the national forests; to land use, farm tenancy, rural rehabilitation, rural electrification, and many other supplementary phases in connection with watershed protection, fire control, soil determination, and soil erosion and control practices; and also in the determination of actual ownership of land.

Nothing devised by the ingenuity of man is more ideally suited to a study of the face of the earth than is an aerial photograph; nothing can portray the physiographic and cultural conditions of the ground, and as they actually exist, including the vegetative and the forest coverage, as well as does a vertical aerial photograph. The utilization of aerial photographs, *alone* or in stereoscopic pairs, has probably been the greatest single factor contributing toward the economic solution of all land-use problems.

The single-lens vertical aerial photograph, or some adaptation thereof, has served the greatest need of all departmental agencies in studying and determining many heretofore intangible factors, the procurement of which theretofore has had to be obtained by actual field investigation.

Production and Marketing Administration

The Production and Marketing Administration of the Department of Agriculture has procured and has utilized over 1,750,000 square miles of aerial photography. The principal use made of aerial photographic reproductions by this departmental agency has been to determine acreages of soil-conserving and soil-depleting crops, and also to obtain the acreages on which soil-conserving practices have been performed. To be certain that equitable soil depleting and special acreage allotments were established for all farms in a county, it was necessary that the acreages of the various crops be determined; also the acreages in plow pasture, open pasture, woodland, etc. The aerial enlargements have proved the cheapest and most accurate method for securing the necessary basic data.

Where field boundary lines have changed since the original aerial photographs were taken, sufficient data are secured to permit the agency field representatives to determine new boundary lines, and identify the crops grown or the soil-conserving practices performed. The detail shown on an aerial photographic enlargement offers many advantages not available from a map or from a tracing of a farm.

In the individual county offices of the Production and Marketing Administration the aerial photograph adds greatly to the efficiency of operation. Routes to be followed by farm-reporters at the time farms are checked are planned systematically. When rechecks of acreages are necessary they are made in the county offices without the necessity of having to visit the farm.

The photographs are also used to assist farmers in planning their farm operations such as crop rotations to be followed, conservation practices to be used, etc. Thousands of farmers have purchased photographs for their own use.

Soil Conservation Service

Aerial photographs are used extensively by the Soil Conservation Service. They are used primarily for planning. Specific instances are compiling erosion,

FIGURE 1.—Section of Fayette County, Iowa, before conservation practices were followed.

FIGURE 2.—Same section 3 years later showing results of conservation practices.

land-use, land-slope, and related soils data needed in connection with conservation survey studies. On flood control surveys, information is also taken from the aerial photographs which otherwise would take months to compile. For instance, it is possible to determine the percentage of watersheds covered by timber and by cultivated land. In addition, aerial photographs are used in connection with range, water facilities, irrigation, land capability, and various other types of surveys.

Without the utilization of aerial photographs, it would have been impossible for the program of the Soil Conservation Service to have developed to its present state of progress.

Bureau of Plant Industry

The Division of Soil Survey of the Bureau of Plant Industry, Soils, and Agricultural Engineering has found aerial photographs to be of inestimable value in the field in the correct delineation of soil types. A soil survey consists of the classification and the mapping of soils in terms which show all of their important characteristics in any locality, and hence, show which soils are like and which are unlike those found in other localities. The usefulness of this kind of a soil classification becomes very apparent when the survey is complete. It permits a farmer, for instance, to ascertain whether his soils are similar to soils on experimental fields on which important new farm practices have been tested and found promising; it will also tell him whether his soils are like those on farms in other sections of his state or region on which new crop varieties, tillage methods, or cropping systems have been found successful.

In practice it is found that much of the photographic detail may be sketched on the overlay sheet or photograph before going into the field. Roads, visible section lines, field fences, streams, and even some perfectly obvious soil boundaries, can be traced tentatively. Pictures of hilly wooded country are studied stereoscopically in the office, and in places drainage is drawn under the stereoscope.

The aerial photographs provided by agencies of the Department and by other federal agencies have made a major contribution toward the accuracy of soil maps, and have greatly expedited the soil mapping program of the Bureau.

Forest Service

The Forest Service, in the administration and protection of national forests, is afforded opportunities for employing aerial photographs for a variety of purposes. Range, or vegetative, surveys to determine the extent and type of forage cover are based upon the use of aerial photographs. Estimates of timber stands, the amount of merchantable timber, and the extent of damage by fires, hurricanes, and other forces of nature are now made much easier by the utilization of this new "working tool" of science. The aerial photographs have become a necessary aid in the problem of fire detection and suppression.

In interpreting aerial photographs for forest timber survey purposes it is expected to be able to determine at least forest type, major species, tree heights, crown widths, and a density estimate, or tree count. This information is then supplemented by ground studies to obtain detailed information on species composition and understory not determinable from the pictures; and growth, quality, and reproduction counts.

At present there is no consensus as to the scale of aerial photograph or type

of picture most satisfactory for timber inventory work. Preliminary results indicate a leaning toward a scale of 1:15,840, or 4 inches to the mile. This particular scale fits into a variety of uses in forest type mapping and is sufficiently large to permit fairly detailed interpretation of aerial photographs. Preliminary tests made by others indicate that aerial photographs taken on infra-red film using a minus-blue No. 12 filter give a fairly satisfactory differentiation between hardwoods and softwoods and between several species within the softwood group. A contract has recently been awarded for photographs of this sort, covering a sizeable area, for additional study in locations where different timber species exist. Most of the aerial photographs now available for timber areas are on the ordinary panchromatic film. Experience indicates that such pictures, even though used with a filter, do not differentiate satisfactorily between species.

Considering the needs for photographs in the study of erosion, drainage and reservoir studies, transportation planning, road and trail reconnaissance location, cadastral surveys, acquisition surveys, selection of unit boundaries, boundary surveys, and other forest activities, use of them by the Forest Service has yet to reach its peak and aerial photography is expected to make further strides in these fields.

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FIFTH ANNUAL CONFERENCE ON SURVEYING AND MAPPING HELD IN TEXAS

The Fifth Annual Conference on Surveying and Mapping conducted by the School of Engineering, Departments of Civil Engineering of the University of Texas and the A. & M. College of Texas, in co-operation with the Texas General Land Office, was held at College Station, Texas, on March 26–27, 1947. A variety of papers were presented and a number of problems discussed dealing with engineering surveys, legislation, and education.

W. P. Moore, Civil Engineer of Austin, presented a paper on "Explanation of House Bill 629, Creating a Bureau of Controlled Surveying and Mapping." Licensing of surveyors was discussed by General Land Commissioner Bascom Giles in a paper, "Proposed Legislation Affecting the Land Surveyors." "Texas Land Laws of Interest to Surveyors," in which "vacancy" and "excess" were discussed, was the subject of a paper by John Campbell, Attorney for the General Land Office, Austin.

Other papers presented were: "Surveys West of the Pecos," by Major W. J. Powell, Consulting Engineer of Dallas; "Surveying in the Gulf of Mexico," by W. H. Wilson, Senior Engineer, Humble Oil & Refining Co., Houston, in which the uses of the various types of Radar equipment by oil companies were described; "Control of Aerial Photography by Balloon Triangulation," by C. W. Stewart, Corps of Engineers, Galveston, which was accompanied by an outdoor balloon demonstration; "Aerial Photo-Geologic Interpretation as an Aid to the Engineer," by Frank Evans, Photo-Geologist of Shell Oil Co.; "The Use of the Texas State Coordinate Systems Illustrated Graphically," by Lt. Comdr. George A. Nelson, U. S. Coast and Geodetic Survey; and "Problems in the Teaching of Surveying," by Prof. Leland Barclay of the University of Texas.

The conference closed with a banquet at which Prof. L. V. White of Kansas State College spoke on the early history of land surveying, both ancient and early American.

Joint National Societies Committee

By PROF. GEORGE H. HARDING

CHAIRMAN, JOINT COMMITTEE FOR STATE SURVEYING AND MAPPING CONFERENCES

IT HAS long been felt that no real national progress in surveying and mapping can be made until opportunities for the presentation and hearing of papers and free discussion of them are made available to the majority of those engaged or interested in surveying and mapping. To all but a comparative few, distance, time, cost of travel, available accommodations, and many other factors preclude any general attendance at our annual national society meetings concerned with surveying and mapping.

It has been generally agreed that to reach this vast number of persons engaged or interested in these fields would only be possible by means of annual conferences held within each state and arranged for, and directed to, those engaged in these fields within the state.

The co-operating national societies each have their own particular objectives and principal interests, but the fundamental purpose of improving these fields, and the dissemination and discussion of new developments in both techniques and equipment, is common to all and essential to all real progress. It is further generally acknowledged that the effort to establish and encourage these annual state conferences should be a co-operative one by joint action of the national societies, rather than a competitive effort. It is believed that this co-operative effort, sincerely initiated and carried out, will not only improve the status of the profession on a national scale, but will both directly and indirectly benefit the participating national societies, engender further interest in the governmental surveying and mapping activities, and develop interest in the more modern products of our instrument manufacturers.

To encourage the establishment of such state conferences, a Joint Committee has been organized, composed of representatives of co-operating national technical and professional societies interested in or concerned with the development of any or all phases of surveying and mapping. Represented thus far on the Joint Committee are the American Society for Engineering Education, the American Congress on Surveying and Mapping, and the American Society of Photogrammetry.

The specific objectives of the Joint Committee are as follows:

1. To encourage and co-operate with, wherever requested, state conferences on surveying and mapping already established and presently functioning.
2. To encourage and co-operate with the re-establishment of state conferences on surveying and mapping which were discontinued during the war.
3. To initiate endeavors in states where state conferences on surveying and mapping have not been held, to establish such annual conferences. This situation applies to the majority of our states.
4. To provide a medium for, and to encourage, co-operation between established state conferences and those in process of organization, by making available to the new efforts the results and experiences of past conferences.
5. To provide a medium for the exchange of ideas between state conferences concerned with the same or similar problems.

6. To provide a means whereby outstanding papers and programs presented in individual states may be brought to the attention of the entire profession by making such papers available to the publications committees of the co-operating national societies for possible publication.

Each member of the Joint Committee holds his committee assignment by virtue of appointment of the Chairman of the Committee, subject to the confirmation of that appointment by the administration of the national societies. The Joint Committee members hold their appointments for 3 years. Within the Committee itself, each member represents all of the participating national societies of which he is a member and who have confirmed his appointment.

The Joint Committee is considered to be a continuing or permanent committee of all the participating national societies until such time as its objectives are accomplished or until it is felt that no further progress can be made. The Chairman of the Joint Committee, following a period of initial committee organization, will be chosen each year by the current members of the committee by a ballot vote. The Joint Committee will be directly responsible to the administrations of all the co-sponsoring national organizations. Progress and annual reports will be prepared by the Chairman, will be identical, and will be made simultaneously to all of the national societies participating.

Initial State Conference Held in Georgia

The first tangible results of the efforts of the Joint Committee were realized on March 21–22, 1947, at the Georgia School of Technology in Atlanta, Georgia. This initial conference was designated by the Georgia State Committee, acting under the leadership of Professor Ralph P. Black, a member of the Joint Committee, as a Short Course in Surveying and Mapping. Professor H. B. Aikin of the University of Tennessee attended this conference as the official representative of the Chairman and reports that the conference was eminently successful. Attendance included about 80 individuals, for the most part from Georgia. However, it did include a few from some other adjacent states. As a result of the conference, an organization of county surveyors and county engineers was established for the purpose of improving certain aspects of this field within the State. This new organization also intends to interest itself in certain State legislation affecting the surveying and mapping field, and certain proposed laws to effect this improvement were presented and discussed during the conference.

Professor Black is to be congratulated, as are also his colleagues and coworkers, in the successful effort undertaken in the State of Georgia. It is hoped that this example will prove a source of encouragement to the many similar efforts now under way as the result of the activities of the Joint Committee.

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CASE INSTITUTE OF TECHNOLOGY

After next month the Case School of Applied Science, Cleveland, Ohio, will be known as the Case Institute of Technology. Changing the name of the institution, which came into being in 1880, was brought about by President William E. Wickenden and confirmed April 1, 1947 by an order from the Court of Common Pleas of Cuyahoga County. The reason given by Dr. Wickenden for changing the name was that the old one was out of line with the character of the present-day institution.—*Engineering News-Record* (News Issue), May 8, 1947.

Photogrammetry Society Meeting

THE American Society of Photogrammetry held its thirteenth annual meeting at the Wardman Park Hotel in Washington, D. C., on January 22–24, with more than 600 persons in attendance.

Technical sessions began on the morning of the 23rd, the theme of the day's meeting being "International Co-operation in Photogrammetry." In the opening address, Mr. W. E. Wrather, Director of the U. S. Geological Survey, pointed out the numerous international aspects of the photogrammetric science and the mutual bond of interest between photogrammetrists of this and other nations. He was followed by General Ramiro J. Perez Quintanilla, Chief of the Mexican Army Map Service, who emphasized the value of science in making a new and better life, and called attention to the progress of photogrammetry along that line. Sr. Alfonso Vaca Alatorre described a system of mapping used in Mexico, basically of a radial-line nature, in which a series of extra transverse flights were used to avoid a certain amount of ground control. The morning session was concluded with an unscheduled paper describing the photo-mapping program in Venezuela.

At the afternoon session, Mr. Leon T. Eliel, President of Fairchild Aerial Surveys, gave a historical summary of the early beginnings of photogrammetry in the United States and of its rapid expansion in the years after 1930. Mr. John Carroll, Department of Mines and Resources, Canada, explained the Canadian mapping program and pointed out that although difficult flying conditions were encountered, they were obtaining about 200,000 square miles of aerial photography a year. He said the trend in Canada has been toward the use of a plate camera.

At the morning session of the 24th, Mr. Edmond Staub of the Wild Co., Heerbrugg, Switzerland, presented a paper on "Photogrammetric Practices in Switzerland." He stated that the usual Swiss mapping procedure was of a stereo nature and that they were also using plate cameras. "Resolving Power of Photographic Lenses" was the title of a talk by Dr. Konstantin Pestrecov, of the Bausch and Lomb Optical Company. He told of the different types of resolution targets and made a comparison of testing lenses by photographic as against visual methods. Dr. Andre Simonpietri, Secretary, Commission on Cartography of the Pan American Institute of Geography and History, spoke on "The Future of Mapping in the Americas." His remarks were optimistic, in that although vast areas remained unmapped, and a great deal of mapping of only a reconnaissance nature was still being performed, the future appeared bright because of the new techniques springing up and because of the extensive mapping agencies being set up by the various nations.

At the final afternoon session, Dr. John M. Calhoun of Eastman Kodak Co., spoke on "Physical Properties and Dimensional Stability of Aero Film." He compared various types of films, notably nitrate versus safety film, and film versus glass plates. Preparations for the Pacific atomic project were discussed by Colonel Paul T. Cullen, U. S. Army Air Forces. This was followed by a showing of the film "Operation Crossroads."

The newly elected officers for 1947 are: President—Revere G. Sanders; First Vice President—Edmund L. Massie; Second Vice President—Russell K. Bean; Secretary-Treasurer—M. K. Linck.

FRANCIS L. WITKEGE

Federal Surveying and Mapping Agencies

This is another in the series of sketches of the history, purpose, and scope of activities of federal agencies engaged in surveying and mapping.—EDITOR.

PUBLIC ROADS ADMINISTRATION

Federal Works Agency

ORGANIZATIONAL HISTORY AND FUNCTIONS

THE PUBLIC ROADS ADMINISTRATION had its beginning as the Office of Road Inquiry, created by the Secretary of Agriculture in 1893 under authority of the Agricultural Appropriation Act for the fiscal year 1894. It has since functioned under various names. The Federal-aid Road Act of July 11, 1916, initiated federal aid for highways and placed administration under the Secretary of Agriculture, who functioned through this organization, known then as the Office of Public Roads and Rural Engineering, and after July 1, 1918, as the Bureau of Public Roads. The authority of the Secretary of Agriculture was continued by the Federal Highway Act of November 9, 1921, and he continued to act through the Bureau of Public Roads. Under the reorganization effected July 1, 1939, all functions of the Secretary of Agriculture relating to the administration of the Bureau of Public Roads were transferred to the Federal Works Administrator and the bureau became the Public Roads Administration of the Federal Works Agency.

The Public Roads Administration is the principal road-building agency of the Federal Government. It administers the regular federal-aid funds and the emergency appropriations for road construction, and conducts researches in the fields of highway design and highway economics. It co-operates with the Department of Agriculture in the construction of forest roads, and supervises the construction of national park roads for the National Park Service. A large part of its work is done co-operatively with the highway departments of the various states, and contact with them is maintained through a regional office at San Francisco, 13 district offices, and state representatives.

SURVEY AND MAP WORK

The Public Roads Administration does not itself engage in surveying primarily for mapping purposes. It passes on surveys made by State Highway Commissions for federal-aid construction projects, and performs miscellaneous surveying work for road construction projects on federal reservations.

The mapping activities of the organization are limited to compiling and drafting maps showing the progress of construction on the Federal Highway System, and certain other maps described below.

The Public Roads Administration first became seriously involved in map compilation through a provision in the Federal Highway Act of November 9, 1921,

Prepared in the Office of the Public Roads Administration, Washington, D. C.

Fairchild Aerial Surveys, Inc., N. Y.

"PRETZEL" INTERSECTION, SOUTHERN STATE PARKWAY AND WELLWOOD AVENUE, PINE LAWN, LONG ISLAND, N. Y.

which required the Secretary of Agriculture to "prepare, publish, and distribute a map showing the highways and forest roads that have been selected and approved as a part of the primary or interstate, and the secondary or intercounty systems"; and periodically thereafter to "publish supplementary maps showing his program and the progress made in selection, construction, and reconstruction." To meet this requirement of the law—a single map of the United States having been found inadequate in scale—maps of the 48 States were compiled to a scale of 1:500,000 (1:760,320 for the Western States) and overprinted in red and blue and letter symbols to show, respectively, improvement, with or without federal aid, and the general class of surfacing. This Federal-aid Highway System Progress Map series was begun in 1925 and was kept up to date to the beginning of the war emergency, when publication was discontinued and the maps withdrawn from distribution. It is doubtful if publication will be resumed because of the limited usefulness of these maps in comparison with the Transportation Map series, now in course of compilation and publication, which fulfills the requirement of the law and serves many additional purposes.

After the adoption of the U. S. system of uniform marking for interstate highways in 1926, Public Roads prepared and published an overprint on the General Land Office wall-size base map, showing the system of U. S. numbered highways and all non-coincident highways of the federal-aid system. This wall map is revised from time to time to reflect changes in the U. S. highways and the system of federal-aid highways. The latest edition is corrected to January 1, 1943.

The Transportation Map

In 1932, specifications were drawn up for a new type of state map designed for administrative use and reference by federal and state agencies, and especially for use by Public Roads as a project record map, in the absence of any other suitable published highway maps of the states at that time. It is published as a general transportation map to show all the media of transportation except pipelines and aqueducts—which have been omitted for military reasons.

The Transportation Map is a joint compilation by Public Roads Administration and the U. S. Geological Survey. Copy for the highways and related features is prepared by Public Roads personnel. Compilation of the base, drafting of the manuscript map, and lithographic reproduction are carried out by the Survey. The map is printed in color at a scale of 1:250,000 on sheets of uniform size, 36 by 26 inches over-all. The rectangles are oriented with the long dimension east and west and laid out independently for each state. The larger metropolitan areas are shown in greater detail as insets at a scale of 1:125,000, or as special sheets, such as those of New York City and vicinity, and the Philadelphia-Camden area.

These maps show railroads, commercial airways and airfields, canals, and navigable waterways; and, in the category of highway information, by color and symbol, differentiation of federal-aid highways, state primary highway routes, forest system highways, national parkways, and principal county or connecting roads. U. S. highways are identified by the shield-enclosed U. S. number, and circle-enclosed numbers identify the other state system routes. Six general classes of surface improvement status are shown by symbol on state primary routes (including the federal-aid system routes). Related information is also shown, such as the boundaries of the larger incorporated places, national forests and parks, Indian reservations, national wildlife refuges, and other federal reservations, and state forests and parks.

Although designed especially for official use by federal and state agencies, the Transportation Map enjoys an increasing popularity and a growing distribution to libraries, educational institutions, commercial map publishers, and transportation companies. Maps have been published for 26 states and are in process of compilation for others. When completed they will total 441 sheets. They are available to the general public by purchase from the Superintendent of Documents, Washington 25, D. C., in complete sets for a state, at prices based on the cost of paper and printing.

The only other map regularly published by Public Roads Administration is a 1:5,000,000 scale desk-size map of the United States, showing, in red overprint, the U. S. numbered highways according to the most recent corrections by the American Association of State Highway Officials. The latest edition of this map is corrected to January 1, 1943.

The County Map

Along in the early thirties the improvement of the main interstate highways of the United Sates had progressed to the point where further application of federal aid involved, increasingly, programs of modernization and relocation of the principal routes. At the same time, the extension of federal-aid construction to secondary or feeder roads, begun as a work relief measure during the depression years, raised problems in the selection of qualified projects, requiring economic

data not readily available. The lack of suitable maps throughout large areas of most states was another serious handicap to highway planning, the need for which had suddenly become acute.

The Hayden-Cartwright Act of June 18, 1934, and subsequent authorizations of federal-aid appropriations, earmarked 1½ percent of the funds apportioned "for surveys, plans, and engineering investigations of projects for future construction. . . ." Under that provision of the law, there have been organized in all of the states "state-wide highway planning surveys," which operate as federal-aid projects under joint supervision of the respective state highway departments and Public Roads Administration, with generally uniform practices and procedures. These highway planning surveys have been effective in the compilation and tabulation of data essential to intelligent planning, which were previously unavailable or difficult to acquire.

A basic activity in these highway planning surveys has been the taking of an inventory of every mile of public road in each state with all pertinent data of interest in highway planning studies. An important result has been the compilation of county highway maps to scales of 1 or 2 inches to the mile on which have been delineated all of the public roads, together with such other information acquired through the highway inventory as lends itself to representation by lines or symbols on a map. Practically all of the 3,070 counties have been thus mapped in four series.

The basic map is a general highway map on which, besides the roads and their current improvement status, are shown railroads and other media of transportation, drainage features, boundaries of incorporated places and other civil subdivisions, national and state reservations, and cultural features in great variety identified by symbols. The other three series show, respectively, on the general highway base, traffic flow (by shaded bands of proportionate width or by other symbolization), school bus routes, and post route data. The highway information on these maps is brought up to date from time to time and comprehensive correction is carried out as the need accumulates.

These county maps have proven tremendously useful—not only in the field of highway planning, but for numerous other purposes. Not all of these maps possess the qualities of cartographic excellence and high geodetic accuracy, but they offer the user one element of paramount value—authentic, detailed, and up-to-date information in wide variety. This nation-wide inventory of 3,000,000 miles of roads and related cultural features and the mapping of over 3,000 counties in such a brief period of time furnishes a convincing demonstration of the workability of federal-state co-operation under the principles adopted in the administration of federal aid.

The State Map

Besides the county maps, general highway maps of most of the states have been compiled at varying scales, but commonly at the scale of 1 inch to 8 miles. These maps show the state primary highways and generally the more important connecting roads, with surface type classification indicated by road-band symbols.

Both the county and state maps may be purchased from the state highway departments at prices based on the actual cost of reproduction. Most of the maps are reproduced as blueline prints from paper negatives, although a few states have published excellent lithographic printings. Many of the states offer half-scale reproductions at greatly reduced prices. Inquiries should be addressed to the

state highway departments at the respective state capitals, except in the cases of Maryland, where the State Roads Commission is located in Baltimore, and Iowa, where the State Highway Commission is located in Ames.

Aerial Photography in Highway Engineering

Aerial photography is the new instrument at the service of the highway engineer. He has barely started to explore its possibilities, but he is properly interested. The potentialities of both aerial and terrestrial photogrammetry in relation to highway planning and design are just beginning to take form.

With existing equipment it is possible to make satisfactory topographic maps at a scale of 1 inch to 200 feet with 5-foot contour interval. At this scale remarkably close approximations of construction costs can be worked up and reliable comparisons made between alternative locations under study. Adequate aerial photographic highway surveys are now being carried out at a cost of around $600 per centerline mile. These large-scale maps and the accompanying aerial photographs and aerial photograph mosaics are particularly useful in elucidating the relative merits of competing locations to executive boards or commissions, whose members are generally untrained in the interpretation of ordinary blueprint plans. Ground surveys of comparable adequacy would not only cost more and consume weeks of extra time but might fail in their primary purpose, a convincing presentation of the pros and cons.

There are no insurmountable technical obstacles in the way of future expansion in the application of aerial photogrammetry to the location, and eventually to the design, of ordinary rural highways.

Postwar Highway Program

The Federal-aid Highway Act of 1944 authorized the administration of $500,000,000 as aid to the states in highway construction in each of the first three postwar fiscal years. The yearly amount is assigned $225,000,000 for the federal-aid system, $150,000,000 for farm-to-market or secondary roads, and $125,000,000 for urban sections of the federal-aid system. An important feature of the new program is the designation of a National System of Interstate Highways not exceeding 40,000 miles in extent. This system will be included in the federal-aid system and be eligible for improvement with federal-aid system funds. Planning of this system and of a system of secondary or farm-to-market roads and actual launching of construction of the three classes of work are being carried on actively in co-operation with the states.

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Federal Surveys and Maps—Accomplishments 1946

During 1946 the federal surveying and mapping agencies adjusted their organizations to peacetime objectives and clarified their respective programs for the immediate future. Practically all agencies with substantial survey and map-making capacities had, since 1941, devoted the greater part of their facilities to projects required by the War and Navy Departments and not all of such assignments were brought to a close with the termination of the war. The global aspects

and air power of World War II brought a realization that considerably less than one-quarter of the world-at-large was mapped—even in sufficient detail for the meager requirements of aeronautical pilotage. This situation was very substantially improved during the war but much work remains to be accomplished in the next decade, particularly in view of the potential speed and power of any military operations which might arise in the future. Projects carried by civilian agencies for the military have, therefore, not all been terminated and the few which have been continued now assume more or less long-term aspects. This, in turn, has enabled the agencies to adjust their organizations to substantially cover their normal responsibilities as well.

Great advances in mapping techniques, instruments, and procedures were realized during 1946. Many of the forward steps brought by the exigencies of war, such as the development of the trimetrogon process of reconnaissance mapping and electronic devices for air navigation, and many other activities, were brought to still further advanced stages during 1946. The terrain clearance indicator and the various elements of Shoran equipment now show great promise of more extensive applications to geodetic, hydrographic, and reconnaissance topographic surveys in the reasonably near future. Electronics are already extensively employed in geophysical explorations as well as certain phases of the other types of surveys just mentioned.

The surveying and map compilation projects of the Federal Government cover a very broad scope of endeavor and include geodetic, geologic, hydrographic, topographic, cadastral, soil, and many other types of surveys as well as map compilation involving innumerable subjects and purposes.

The accomplishments of the various producing agencies, as well as those mainly concerned with map research and the maintenance of important map libraries have been abstracted by the Map Information Office of the Geological Survey from data furnished it by the various agencies concerned. The report is available in mimeographed form and will be furnished free of charge on request to the Director, U. S. Geological Survey, Washington 25, D. C.

C. F. FUECHSEL

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Isogonic Chart of U. S. Available

THE DISTRIBUTION of magnetic declination throughout the United States and adjacent regions, as of 1945, is shown in a new edition of "Isogonic Chart for 1945," recently issued by the U. S. Coast and Geodetic Survey.

The present edition is on a new base map, prepared to a scale of 1:5,000,000 instead of the former scale of 1:7,000,000. Other departures from the 1940 and previous editions are the showing of cities, towns, lakes, and important rivers to a greater extent than before, and the inclusion of Bermuda and a part of Newfoundland. The isogonic lines are derived from the observed values by a method that gives more consistent recognition to local irregularity than was obtainable by former methods.

This new edition is printed in five colors on heavy chart paper, 31 by 47 inches in size, and is supplied unfolded. It may be obtained, at a cost of 40 cents, from the Director, U. S. Coast and Geodetic Survey, Washington 25, D. C.—*Civil Engineering*, February, 1947.

Property Surveys Division

"CANONS OF PRACTICE" AND OTHER ACTIVITIES

In order to implement the new Technical Standards for Property Surveys, the Property Surveys Division has launched upon a campaign to develop what might be termed "Canons of Practice, or By-Laws to the Standards." These canons or by-laws would be the consensus of the profession on specific detailed matters that arise in professional practice.

At the present time the executive committee of the Division is studying the question of a proper procedure for handling requests for reprints of old surveys, both from the original client and others. This particular question has long been the subject of debate among practicing surveyors. Should there be a charge for reprints of old surveys, other than mere blueprinting costs? Should the reprints be furnished only to the original client, or to no one at all, after a prescribed period of time?

The Division is also beginning a nationwide study of surveying fees under the chairmanship of Mr. Ford Bartlett of Brooklyn, New York. It is hoped to develop a standard of practice, and a greater uniformity at least in the theory of professional fees, bearing in mind that a principal characteristic of any profession is unity and uniformity, plus agreement in principle on major problems.

The executive committee of the Division will welcome suggestions from its members for subjects to be studied in a similar manner, and does at all times urge the contribution of opinions on all such discussions.

DISSEMINATION OF TECHNICAL STANDARDS

For the past twenty years I have been quite active in various professional engineering societies, primarily for the reason that I have always felt that my particular specialty, surveying, was so sadly in need of professional improvement. I have worked in a number of societies and still do, but I am pinning most hope on the American Congress on Surveying and Mapping. Though a pessimist by nature, I have hopes that we can accomplish something for our profession through the Congress.

The Technical Standards developed by the Property Surveys Division are potentially of more importance than I think is generally realized. To develop their full potentialities becomes our important job. The Congress itself must, I think, deal with the national organizations. In spite of the relative youth of the Congress compared to these other organizations, I feel that the Standards themselves are of sufficient importance to entitle the Congress to request the endorsement of them, even of ninety-odd-year-old A.S.C.E.

The Division itself will have to carry on at the local levels. I am introducing a resolution at the next meeting of the Cleveland Society of Professional Engineers for the adoption of the Standards and the subsequent adoption by the Ohio Society of Professional Engineers. I anticipate no difficulty. I have submitted copies to the major title companies in Cleveland. The Standards have been welcomed by the title companies and I have had requests for additional copies.

The title companies have complained strenuously in Cleveland of inadequate surveys that have been presented to them, and their difficulty in getting proper surveys in some instances because of the lack of any standards except their own. I have proposed to these title companies that now, in such cases, they reject such inadequate surveys on the basis of non-compliance with the approved Standards of Practice of the profession. The title companies on the whole were pleased with this opportunity to relieve themselves of accusations of arbitrary positions.

A committee, headed by Mr. Ralph M. Berry of the U. S. Coast and Geodetic Survey, will have the responsibility of co-ordinating the activities of promotion and distribution of the Standards, and of recording such successes as may result.

S. A. BAUER, *Chairman*

(EDITOR'S NOTE.—Since receiving the above, Mr. Bauer has informed the Congress that at the February meeting of the Cleveland Society of Professional Engineers the Technical Standards for Property Surveys were adopted.)

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Resurvey

(IT'S A DOG'S LIFE)

There was a hundred-acre grant
We set out to retrace,
And like a hound with nose to ground
Searched every likely place,
Nor found a single trace.

Where once a little village stood
With boundaries plain and clear,
Time marches on, the lines were gone
As Nature, year by year,
Had made them disappear.

My axeman gave a joyous cry,
"Come chief, your search is done,
For here I've found a corner bound,
It must be the right one."
I went there on the run.

He'd found a well-built mound of stones,
While on a nearby tree
In letters plain, I read with pain:
"Died 1883.
Poor Fido, R.I.P."

—*The Canadian Surveyor*

Surveying and Mapping News

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING.—EDITOR.

CURRENT SURVEYING AND MAPPING LITERATURE

MAGAZINE ARTICLES

EL PRIMER MAPA GEOLÓGICA DE COLOMBIA. Victor Oppenheim, *Revista de la Academia Colombia de Sciencias Físicas y Naturales,* December 1943. (History of the preparation of the geologic map of Colombia, with map supplement.)

ESTUDIO DE LA PROYECCIÓN SINUSOIDAL PARA EL MAPA DE COLOMBIA. *Revista de la Academia Colombia de Sciencias Físicas y Naturales,* August 1944. (A mathematical discussion of the sinusoidal projection, including comparison with Gauss transverse projection used by Colombia.)

THE APPLICATION OF OIL-WELL SURVEYING INSTRUMENTS AND TECHNICAL SERVICES IN THE MINING INDUSTRY. G. L. Kathny, *Mining Technology,* January 1946. (Describes various oil-well surveying instruments and how they can be adapted for use in mining drilling.)

MAP PROJECTIONS AND THE GLOBAL WAR. Erwin Raisz, *The Teaching Scientist,* January 1946.

THE BEGINNINGS OF PHOTOGRAPHIC RECONNAISSANCE. H. Hemming, *Aeroplane* (London), January 11, 1946. (History of development of aerial photographic surveying in England prior to the war.)

LAND SURVEYORS' EXAMINATION (Australia and New Zealand). *The Australian Surveyor,* March 1946. (Twenty-two hours allotted to examination covering Land Surveying Computations, Engineering Surveying, Astronomy and Geodesy, Town Planning, Physics, Geology, and Forestry.)

ECONOMICS OF PHOTOGRAMMETRY. Oliver S. Reading and Leon T. Eliel, *Proceedings, American Society of Civil Engineers,* March 1946. (Closing discussions of an article by Mr. Eliel, published in the March 1945 *Proceedings.* Previous discussions appeared in *Proceedings* as follows: June 1945, by Raymond A. Hill, Raymond L. Moore, and Ralph S. Pearse; October 1945, by George D. Whitmore, Benjamin A. Wasil, Charles H. Davey, and Robert H. Randall; and December 1945, by W. J. Ryan.)

ENGINEERING EDUCATION (PROGRESS REPORTS OF THE SOCIETY'S PROFESSIONAL COMMITTEE ON ENGINEERING EDUCATION, FOR 1944 AND 1945.) *Proceedings, American Society of Civil Engineers,* March 1946. (Analyses and statistical data on curricular requirements of accredited civil engineering institutions in 1944 and 1945. Includes a discussion on the Report of SPEE Committee on Engineering Education After the War.)

SOME THOUGHTS ON ENGINEERING EDUCATION. Donald M. Baker, *Proceedings, American Society of Civil Engineers,* April 1946. (Views of a practicing engineer on engineering education, organization of the engineering profession, and general conditions of engineering practice.)

THE DISTORTION OF ANGLES IN GENERAL CARTOGRAPHY. Edward Kasner and John De Cicco, *Proceedings of the National Academy of Sciences,* April 1946.

SHORAN PRECISION RADAR. Stuart William Seeley, *Electrical Engineering,* April 1946. (Describes the development, principles, and equipment of Shoran navigational radar.)

PRECISE CONTROL SURVEYS FOR BASIN AND RAIL EXTENSION OF DAVID W. TAYLOR MODEL BASIN. Lansing G. Simmons, *Transactions, American Geophysical Union,* April 1946. (An account of the technical details involved in making control surveys for extending the length of the Taylor Model Basin from 1300 to 1800 feet.)

SOME DEVELOPMENTS IN AERIAL PHOTOGRAPHY DURING THE WAR. L. E. Nugent, Jr., *Bulletin of The American Association of Petroleum Geologists,* May 1946.

THE MAGNETIC WORK OF THE UNITED STATES COAST AND GEODETIC SURVEY AT PARICUTIN VOLCANO, MICHOACAN, MEXICO, 1945. Fred Keller, Jr., *Transactions, American Geophysical Union,* June 1946.

ADJUSTMENT OF TRAVERSE. Earl Saunders Belote, *Transactions, American Geophysical Union,* June 1946. (Describes a method of relating the corrections to the measured distances and the corrections to the observed angles in the adjustment of traverse to achieve a fit with the fixed data with the least distortion.)

A GRAPHICAL METHOD FOR DETERMINING TERRESTRIAL LATITUDE AND LONGITUDE. W. H. Stillwell, *The Canadian Surveyor,* July 1946. (An equal altitude method requiring four stars, one in each quadrant. Accuracy obtained is within limits of uncertainty of the instruments used.)

RADAR SHOWS PROMISE IN MAPPING. *Civil Engineering,* July 1946. (A symposium presented at a special conference of the ASCE Surveying and Mapping Division, discussing mechanics and application of Shoran in position determination for geodetic and hydrographic surveying, and Loran as an aid to navigation.)

THE AIRBORNE MAGNETOMETER. Gary Muffly, *Geophysics,* July 1946. (Discusses magnetic exploration for oil from an aircraft and describes a new type of saturation magnetometer.)

COTANGENT RULER FOR SIMPLIFYING GRAPHIC SOLUTION OF PROBLEMS IN STRUCTURAL GEOLOGY. W. S. White, *Economic Geology,* August 1946. (A device for measuring directly dip of contoured surfaces.)

CONTROLLING PLANE POSITION IN AERIAL MAGNETIC SURVEYING. H. Jenson and J. R. Balsley, Jr., *Engineering and Mining,* August 1946. (Describes operating techniques involved in surveying with airborne magnetometer.)

ENGINEERING APPLICATIONS OF AERIAL RECONNAISSANCE. D. J.

Belcher, *Bulletin of the Geological Society of America*, August 1946. (Discusses use of aerial photographs in engineering planning and construction and identification of soils by characteristic patterns.)

HISTORICAL ORIGIN OF BOUNDARIES. Stephen Rose, *The Military Engineer*, September 1946. (Describes some of the national and international boundaries that have been the subject of dispute.)

AIR-SURVEYING METHODS FOR HIGHWAY LOCATION. D. N. Kendall, *Roads and Bridges* (Canada), September 1946.

SPACE RESECTION PROBLEMS IN PHOTOGRAMMETRY. P. H. Underwood, *Proceedings, American Society of Civil Engineers*, September 1946. (Gives a solution of the resection problem in space to find the position of a camera station and to obtain orientation data for a vertical photograph with a small amount of tilt.)

RECENT PROGRESS IN GEODETIC SURVEYS IN THE UNITED STATES COAST AND GEODETIC SURVEY. H. W. Hemple, *Transactions, American Geophysical Union*, October 1946. (Covers activities of Coast Survey during fiscal year 1946.)

THE USE OF MEAN SEA LEVEL AS A GEOPHYSICAL DATUM. H. A. Marmer, *Transactions, American Geophysical Union*, October 1946.

AZIMUTH DETERMINATIONS FROM NON-CIRCUMPOLAR STARS NEAR ELONGATION. F. R. Gossett and A. D. Sollins, *Transactions, American Geophysical Union*, October 1946. (Compares this method with azimuth determinations obtained from Polaris observations.)

EXPERIMENTAL POSITION DETERMINATION BY PENDULUM ASTROLABE. F. R. Gossett and A. D. Sollins, *Transactions, American Geophysical Union*, October 1946. (Compares this method with standard methods.)

SURVEYOR'S PARABOLIC VERTICAL CURVE SIMPLIFIED. J. A. Oakey, *Civil Engineering*, October 1946. (An explanation of parabolic vertical curves commonly used in route surveying at intersection of two different grades, including a derivation of the equation of the curve.)

TRIMETROGON AERIAL PHOTOGRAPHY—OIL INDUSTRY'S NEWEST SURVEYING TOOL. R. W. Disney, *Oil & Gas Journal*, October 1946. (Describes process of making finished topographic base map.)

A MODIFIED WILSON PHOTOALIDADE. John Carroll, *The Canadian Surveyor*, October 1946. (For plotting topographic detail from oblique air photographs by methods analogous to those of the planetable.)

DROWNED ANCIENT ISLANDS OF THE PACIFIC BASIN. H. H. Hess, *American Journal of Science*, November 1946. (Suggests the hypothesis that the summit surfaces of these ancient islands are very old and possibly represent marine planation surfaces in a Pre-Cambrian ocean.)

BALANCED DESIGN IN URBAN TRIANGULATION. Charles D. Hopkins, *Proceedings, American Society of Civil Engineers*, November 1946. (Concluding re-

marks by author of original article of same title published in the November 1945 *Proceedings*. Previous discussions appeared in *Proceedings* as follows: April 1946, by Walter S. Dix; and September 1946, by Henry W. Hemple, L. G. Simmons, C. A. Whitten, and Ronald F. Scott.)

SUBMARINE RELIEF OF THE ALEUTIAN TRENCH. Harold W. Murray, *Transactions, American Geophysical Union*, December 1946.

ASTRONOMIC CONTROL FOR WARTIME MAPPING OF NORTHERN CANADA. Noel J. Ogilvie, *Transactions, American Geophysical Union*, December 1946. (Includes general material on living conditions and natural resources.)

BOOKS AND PAMPHLETS

MODERN SEAMANSHIP. A. M. Knight. *D. Van Nostrand Co., Inc.*, New York. 1945. Eleventh edition. 948 pages. $5.00. (Revised edition includes new material on revised rules of the road and weather.)

THE ENGINEER IN SOCIETY. J. Mills. *D. Van Nostrand Co.*, New York. 1946. 196 pages. $2.50. (A group of essays dealing with the relationship of scientists and engineers to world society; includes six essays on developing creative thought and better writing.)

ELEMENTS OF LORAN (PB–25369). B. W. Sitterly. *Office of Technical Services*, Department of Commerce, Washington, D. C. 45 pages. Photostat $4.00; microfilm $0.50. (A general exposition of the principles of the Loran system.)

SOUL OF LODESTONE, THE BACKGROUND OF MAGNETICAL SCIENCE. Alfred Still. *Murray Hill Books, Inc.* 1946. 233 pages. $2.50. (Guides the reader until the electron and the quantum appear and the atom discloses a structure.)

BUILDING AN ENGINEERING CAREER. C. C. Williams. *McGraw-Hill Book Co., Inc.*, New York. 1946. Second edition. 309 pages. $2.50. (An orientation text for the engineering freshman. Contains a bibliography of visual aids.)

OBSERVATIONS AND RESULTS IN PHYSICAL OCEANOGRAPHY (Oceanography III). O. W. Torreson and others. *Carnegie Institution of Washington*. 1946. 178 pages. (Describes ocean atmospheric-electric results of Cruise VII of the *Carnegie* during 1928–29 under command of Captain J. P. Ault.)

AN INTRODUCTION TO ELECTRONICS. Ralph G. Hudson. *The Macmillan Company*, New York. 1945. 97 pages. $3.00. (An introductory text for those with only an elementary knowledge of mathematics and physics; describes the working principles of modern electronic devices.)

THE FUTURE OF HYPERBOLIC NAVIGATION (PB–2834). J. A. Pierce. *Office of Technical Services*, Department of Commerce, Washington, D. C. 23 pages. Photostat $2.00; microfilm $0.50. (Three hyperbolic navigational systems—the British Gee and Decca and the Loran—are described and evaluated.)

BOOKS RECEIVED

APPLIED PHOTOGRAMMETRY. Ralph O. Anderson. *Edwards Brothers, Inc.*,

Ann Arbor, Michigan. 1946. Fourth edition. 518 pages. (Reviewed in this issue of SURVEYING AND MAPPING.)

PLANE AND GEODETIC SURVEYING FOR ENGINEERS. Volume One: Plane Surveying, 1946; Fourth edition; 636 pages; 30s. Volume Two: Higher Surveying, 1944; Third edition; 511 pages; 30s. David Clark (Revised by James Clendining). *Constable & Company Ltd.*, London. (Reviewed in this issue of SURVEYING AND MAPPING.)

SURVEYING. Harry Bouchard. *International Textbook Company*, Scranton, Pennsylvania. 1947. Third edition. 647 pages. $4.50. (To be reviewed in a later issue of SURVEYING AND MAPPING.)

THE PRINCIPLES AND PRACTICE OF SURVEYING. Volume II: Higher Surveying. Charles B. Breed and George L. Hosmer. *John Wiley & Sons, Inc.*, New York. 1947. Sixth edition. 674 pages. $4.50. (To be reviewed in a later edition of SURVEYING AND MAPPING.)

DISTINCTIVE RECENT MAPS

A number of sheets have appeared of the new National Map of Switzerland on the scale of 1:50,000. Official Swiss topographic maps have long been noted for their beauty and clarity and their refinement of detail, and this new series would seem even to outdo its predecessors. It is being published in four editions: four-color editions with and without relief shading; and two editions without relief shading, on one of which the green tint for forested areas used on the other editions has also been omitted. The program of the Swiss government for replacing its old topographic series, authorized by law in 1935, is to consist of two groups of maps—topographic maps on scales of 1:25,000, 1:50,000 and 1:100,000; and geographic maps on scales of 1:200,000, 1:500,000, and 1:1,000,000. Of these the 1:50,000 series is considered the most urgently needed, and plans call for its completion not later than 1955 and, if possible, in 1951.

The American Geographical Society has received four sheets—Bucarito (Estado Carabobo), Carayaca (Distrito Federal), Rubio (Estado Tachira), and San Diego (Estado Miranda)—of a new topographic map of Venezuela on the scale of 1:25,000 now in preparation by the Ministry of Public Works. The sheets, published in 1945, are produced from aerial photographic surveys. Rivers are distinguished as intermittent or perennial; contours are drawn at 20-meter intervals; areas under cultivation are shown in green with property boundaries in black.

In addition to the series of topographic maps of municipios on scales of 1:50,000 and 1:25,000 mentioned in these notes in the January 1945 issue of SURVEYING AND MAPPING as in process of preparation and publication by the Instituto Geográfico Militar y Catastral of the government of Colombia, this same organization is now engaged on the production of what is called a Carta Preliminar of the country on the scale of 1:25,000. Twenty sheets of this map in the department of Cundinamarca have been published since June 1944. The program is most ambitious, particularly since the designation "preliminar" is used to indicate that the real purpose of these sheets is for eventual use in preparing a map on the scale of 1:100,000. It is to be noted that the published sheets have none of the detail, as regards amount or refinement, to be expected on a map of so large a scale. In fact they appear rather as enlargements from 1:100,000 drawings. The sheets are based on aerial photographic surveys of which the coverage in the country for the purpose is reported to be already extensive, the Zeiss stereopantographic and multiplex machines being used for the purpose. The drafting is on the scale of 1:10,000, and all lettering is by hand.

Attention was called in the last previous installment of these notes to the cartographic work carried on in Denmark and the Netherlands during, and in spite of, the German occupation. In France also, considerable cartographic work was done during the war, although it was seriously reduced by shortage of paper and printing facilities as well as by man shortage. For example, work was continued on the fine Atlas of France, the first sheets of which appeared in 1933 and of which 73 out of a total of 84 plates planned had been published by the end of 1939. Eight more plates were published between 1942 and 1945—a four-plate Vegetation Map, a one-plate Map of Diverse Industries, two plates of a four-plate Chorographic Map, and a plate devoted to Types of Village. In execution and printing these sheets appear to be in no way inferior to the sheets published previous to the invasion.

An outstanding example of the excellent work done by the U. S. Army Map Service during the war in correcting and reprinting official topographic map series of foreign countries, as well as of the postwar value of much of this work, is the 1:50,000 series covering Java and Madura, copied from the Dutch edition of 1924 with corrections from the 1940 edition. A striking feature of this series is the very large number of symbols used. As on all such reprints, legends and notes on each sheet have been translated into English. Each sheet also carries a glossary. The postwar value of reprints such as these is indicated by the fact that previous to the war there were few collections in this country that had more than a few sheets of either of the Dutch editions of this map.

Projection Gnomonique sur un cube á diagonale Nord-Sud (La Terre en six fieulles) is a six-sheet map of the world, ingeniously designed by one Pierre Paris to fit a cube of which one diagonal is the axis of the earth, and published by the Service Geographique of Indo-China. The scale at the center of each sheet is 1:25,000,000; each sheet has one corner at either the North or South Pole and the other three at latitudes 19°28′14″ North and South; the center of each sheet is tangent to the globe at latitude 35°13′55″ North or South. According to the author the map is designed to permit rapid and sufficiently precise solution of problems involved in the laying out and measuring of transoceanic routes, measuring the length of air routes, and long-distance radiogoniometry.

—JOHN K. WRIGHT

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Geological Wall Map of North America

A GEOLOGICAL WALL MAP of North America has been published by The Geological Society of America and is available for distribution. The map, begun in 1940, was compiled by George W. Stose, of the U. S. Geological Survey, from the latest published maps available. The compilation was financed by The Geological Society of America, the American Philosophical Society, and the American Association of Petroleum Geologists, and had the co-operation of the U. S. Geological Survey, the Geological Surveys of Canada and Mexico, state and provincial Surveys of the United States and Canada, and individual geologists.

On a scale of 1:5,000,000, the map is printed in two sheets which, when mounted, make a wall map 76 inches high by 55 inches wide. Selection of the map units, their classification and arrangement in the legend, and adoption of the color scheme are by Mr. Stose. The map is printed in 19 geologic colors, 90 units being represented by color patterns. Orders for the map should be sent to The Geological Society of America, New York 27, N. Y.—*Science*, January 3, 1947.

Books in Review

APPLIED PHOTOGRAMMETRY. Ralph O. Anderson. *Edwards Brothers, Inc.*, Ann Arbor, Michigan. Fourth Edition. 1946. 518 pages. $6.00.

Reviewed by RALPH MOORE BERRY, Chief, Administrative Planning Section, Division of Photogrammetry, U. S. Coast and Geodetic Survey, Washington, D. C.

THE FOURTH EDITION of this widely-discussed work is greatly expanded from the original edition that appeared in 1937 and incorporates the contents of two supplemental publications by the same author, "Tilt of the Aerial Photograph by Graphical Resection" and "Rigorous Analysis of the Scale-Point and Tilt Formulas," as well as a number of additional solutions of specialized applications.

Applied Photogrammetry does not consist of, and is not presented as, a complete treatise on the art and science of photogrammetry in the same sense as the Manual of Photogrammetry of the American Society of Photogrammetry. It is instead a detailed statement with accompanying simple geometrical and trigonometrical proofs of the simple "scale and triangle" methods proposed and developed by the author for the average problems of the determination of the scale and tilt of the aerial photograph. The methods outlined are easy of comprehension and application and might well be adopted by the engineer who has occasional resort to aerial photographs for assistance in the solution of a surveying problem. The author's concepts of "equivalent elevation" and "scale point" derived from comparison of measured ground lengths with their scaled photograph-image distances are unique and interesting and serve as the basis for the development of a complete semi-graphic photogrammetric system.

While it is realized that the entire text is dedicated to the simple solution of common problems with simple and common instruments and that the theory and use of stereoscopic plotting instruments are entirely omitted with complete propriety, it is felt that the value of the book to the practicing engineer who is not a professional photogrammetrist would have been enhanced by the inclusion of a more complete discussion of the principles and applications of the common radial-plot methods.

(EDITOR'S NOTE.—A more detailed discussion of this text is contained in a review by Robert H. Kingsley in the September 1946 issue of *Photogrammetric Engineering*.)

PLANE AND GEODETIC SURVEYING FOR ENGINEERS. Volume One: Plane Surveying, 1946; Fourth Edition; 636 pages; 30s. Volume Two: Higher Surveying, 1944; Third Edition; 511 pages; 30s. David Clark (Revised by James Clendinning). *Constable & Company, Ltd.*, London.

Reviewed by H. D. WALKER, Topographic Engineer, U. S. Geological Survey, Washington, D. C.

THESE are standard English texts on surveying and give very thorough coverage of the entire field as to theory and practice. Since the two volumes were revised at slightly different times, a particular objective in the revision was to avoid changing the layout of the material in the last previous editions, as much as possible, in order that the value of cross references by page numbers will not be destroyed. For this reason most of the new material has been added in the form of appendixes.

The books are valuable as references and of special interest to American engineers because they are written from the viewpoint of English and European practice. These last editions have had material added to cover advances in geodetic methods and in new

instruments. The discussion on survey adjustment and geodetic computation has been extended and material added on coordinate systems and calculating machines. Of special interest in Volume One is the chapter on Tacheometrical Surveying, which is usually not included in American texts.

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A Scientific Defense Against Typhoons

A SCIENTIFIC defense against typhoon damage to the Navy's proposed new harbor at Guam is being worked out by the California Institute of Technology and the Navy's Bureau of Yards and Docks.

A scale model of Apra Harbor, its ocean bottom and adjacent shoreline is being constructed at Azusa, California. Built on a scale of 1 to 300 and measuring 120 feet square, the huge model will provide accurate information on waves, surges, and other hydraulic problems. This knowledge will enable harbor construction to go forward at Guam with assurance that it will provide the best possible defense against storms and other ocean conditions peculiar to the area.

The ultimate size of the Navy's development at Apra Harbor awaits future appropriations, but the planning encompasses an area of Guam covering nearly 7 square miles. The proposed construction will replace where necessary the temporary war-built installations.

The model nearing completion at Azusa is housed in a hangar, 162 feet long, 148 feet wide, and 43 feet high, obtained from the War Department. Inside is a huge basin with concrete bottom and 2-foot steel sides. The "shoreline" within the basin is likewise of concrete and when completed will be accurate even to "beaches" of sand as they occur on the island.

Pneumatic-type wave machines will produce miniature waves and surges, which will be measured electrically and recorded by an oscillograph. Currents will be recorded by time photographs of floating button reflectors on which a strong light is beamed. These measurements will enable engineers to place breakwaters, bulkheads, slips, and drydocks so as to minimize the effects of ocean movements, regardless of the direction from which a storm might come.

It is expected that the model studies at Azusa will have cost approximately $275,000 by the time they are completed in mid-1947. The information which they will provide, however, will more than offset this expenditure by increasing the durability and effectiveness of the Apra Harbor facilities, according to Bureau engineers.—*The Military Engineer,* August, 1946.

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Sonnet LXIV

"When I have seen the hungry ocean gain
Advantage on the kingdom of the shore
And the firm soil win of the watery main,
Increasing store with loss and loss with store;
When I have seen such interchange of state,
Or state itself confounded to decay;
Ruin hath taught me thus to ruminate."

—WILLIAM SHAKESPEARE

New Instruments and Equipment

"Floating" Triangle

A new one-piece triangle manufactured by Instrumaster Industries, Inc., Greenwich, Conn., employs integral embossed buttons to make the lower surface clear the drawing paper by about .020 inch. This "floating" instrument is said to save a draftsman's time by providing an ideal fingerlift at inside and outside edges, avoiding ink smears and mini-

mizing smudges. As each "Instrumaster" 45-degree triangle has a 30–60-degree triangular opening, shifting from one to the other is eliminated.

This floating triangle, of clear non-inflammable plastic stock, guaranteed against warpage, is available in 4, 6, 8, 10 and 12-inch sizes, in both 45- and 30–60-degree types.—*Engineering News-Record*, July 25, 1946.

Dial Indicator

Of interest to industries employing carpenters, shipbuilders, construction men, surveyors, inspectors, or jig makers is a new aluminum spirit level with a dial indicator in the center. Known as the All-Angle Level, the heat-treated tool weighs less than 1 pound, is rustproof, and may be used in any position. The dial indicator—described as accurate to within one-half degree—is protected by an unbreakable-type crystal and is calibrated through a 360-degree range for accuracy.

Two air-bubble tubes, one for horizontal use and one for plumb testing, are incorporated, one on each end. A little over 14 inches long, with a width of 3 inches, the level is manufactured by the Brand Tool Company.—*Scientific American*, December 1946.

Camera Transit

A combination of a camera and surveyor's transit has been developed by Fairchild Camera & Instrument Corp., Jamaica, N. Y., for obtaining the ground control information necessary for aerial photogrammetry. The unit consists of a Type 5078-E Keuffel & Esser transit combined with a 4 by 5-inch plate camera with a telescope mounted on top of the camera, which is fastened to the upper limb of the transit.

The unit is used for terrestrial photogrammetry with the camera transit set up successively at a small number of points in an area in which ground control is necessary and 12 photographs taken at 30-degree intervals throughout a circle at each of the camera stations. By such means most of the measurements needed for other control points in the area can be made in the office so ground control survey costs can be cut as much as 50 percent.—*Engineering News-Record*, October 3, 1946.

Stereo Maker

Anyone can make three-dimensional photographs with an ordinary camera by using the special Stereo-Parallel attachment manufactured by Radex, Inc., of Los Angeles. Simply enough, it amounts to an accurate device for shifting the camera about 2½ inches sideways between exposures. Viewers are available.—*Science Illustrated*, August 1946.

Compass for Small Craft

Marking a radical departure from conventional design, the new Cruiser model compass developed by John E. Hand & Sons Company, Philadelphia, is a compact, rugged and inexpensive instrument suitable for use on both sailing and power boats ranging from 15 to 50 feet.

Among the unusual features of these compasses are internal gimballing—this does away with external rings and provides a free 35 percent swing for the compass card; shock-proofing—the spring-cushioned jewel post and card assembly give high shock resistence and ability to take heavy weather; built in compensation—the patented Deviastat provides a compensating value equal to 35 percent of compass deviation on all quadrants.

The Cruiser compasses are available in a range of sizes from 3 inches to 6 inches and are built of sea-proved materials for high performance, reliability, and long life.—*The Nautical Gazette*, August 1946.

MAP INFORMATION

This department was inaugurated for the purpose of bringing to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. Authoritative articles covering this class of information are solicited. It is believed that through an interchange and dissemination of such information maximum benefits will accrue to the surveying and mapping profession. —EDITOR.

Status of Topographic Mapping in the United States

(See Coverage Map Enclosed)

THE Map Information Office of the U. S. Geological Survey is now conducting an exhaustive study of the status of topographic mapping in the United States and possessions. The purpose of the study is to furnish summarized data of existing topographic map coverage and its relative qualities to the map-using public and to map makers concerned with planning and establishing priorities for new work. A preliminary index—published in SURVEYING AND MAPPING, April–June 1946—showed a tentative appraisal of the topographic mapping of the United States by the Geological Survey, and delineated the areas which were deemed adequately mapped for general purposes and the areas covered by older topographic maps.

The accompanying index map tentatively appraises the status of topographic mapping in the United States by other government agencies as well as the Geological Survey. In the case of the Tennessee Valley Authority the maps produced under the co-operative program, which carry both Survey and TVA sponsorship headings, have been indicated as Geological Survey maps. Proof copies of this index have been sent to various agencies and others concerned with topographic mapping throughout the country. Literature accompanying the proofs describes the standards used in making the appraisal, and it is hoped that a cross section of opinion will be obtained regarding the evaluation and standards used, as well as information on additional mapping which might appropriately be shown. It is emphasized that this index presents only a tentative appraisal, since much work remains to be done in further clarifying standards of appraisal, studying the various requirements of map users, and in critically examining each map upon the standards thus formulated. Meanwhile some index of practical map utility is needed, and the present edition will help to develop a general "point-of-view" for evaluating the present map coverage.

EIGHT MAP CLASSIFICATIONS SHOWN ON INDEX

This index segregates the topographic maps into eight classifications. Mapping done by the Geological Survey is broken down into five general groups, as follows: (1) Surveys made by modern methods with culture reasonably up to

date. The majority of maps in this classification have been produced since 1920, although many produced prior to 1920 also qualify and some produced since 1920 do not qualify. (2) Surveys made by modern methods requiring cultural revision. This classification includes areas where substantial cultural changes have taken place since the field work was done. (3) Older surveys requiring cultural revision and partial resurvey. In general the average standards of survey employed from 1910 to 1920 were considered for this classification. (4) Surveys made by reconnaissance methods requiring complete resurvey. This includes for the most part maps produced prior to about 1910 and those published at scales smaller than 1:62,000. (5) Work in progress. These areas include work actually under way or definitely scheduled for the immediate future.

Mapping done by other government agencies is classified into three additional groups: (1) Topographic maps of standard content. These maps contain the elements and quality essential for general domestic use. (2) Other usable maps. These maps lack certain essential elements. (3) Work in progress.

It will be noted that planimetric maps and maps which have been completely superseded by more recent surveys are not shown in this index. However, older Geological Survey maps are occasionally shown in addition to the later surveys of other agencies. For example, where the later survey, though having up-to-date planimetry, is apparently of lower contour quality than the older Geological Survey map.

A subsequent edition of this index is being prepared which will show manuscript data produced by various agencies for special purposes, of which photostats or other copies may be obtained upon request. The publication of a complete series of index maps is contemplated which will show scale differentiations, segregation by producing agencies, and planimetric maps.

In the near future an index showing the status of mapping in the possessions will also be issued.

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New State Maps Show Triangulation and Leveling Nets

TO ENCOURAGE wider use of the national network of control by local engineers and surveyors, the U. S. Coast and Geodetic Survey has recently inaugurated a new series of state maps—two for each state—showing the schemes of triangulation and leveling nets, respectively. The Geological Survey state maps have been used as a base for this new series, with the scale reduced to about 1:650,000.

For the triangulation sketches the base map has been printed in a light blue, showing place names, county names, and rivers, and the triangulation scheme is shown in black. County lines and the State Coordinate grid are shown in brown. First- and second-order triangulation and traverse and the numerous supplemental and intersection stations located are shown on these maps. (*See* fig. 1.)

In the maps showing the leveling schemes, the county boundaries and the State Coordinate grid zones are shown in brown and the level lines are shown in red. The level lines are numbered, and the local engineer or surveyor desiring

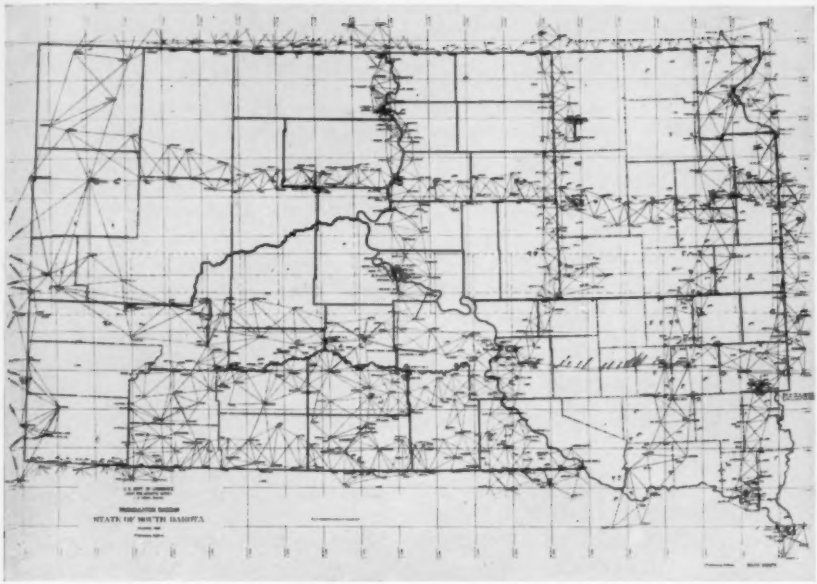

FIGURE 1.—Showing triangulation and traverse stations in South Dakota. Sketch reduced to $\frac{1}{8}$ actual size.

information on any particular level line should refer to the line by its number.

A map of the United States showing the status of the triangulation as of January 1, 1947 has recently been prepared and is ready for issue. There are approximately 100,000 miles of triangulation throughout the United States, and these are constantly being supplemented as current field surveys are accomplished.

A map of the United States showing the leveling accomplished throughout the country is also available. There are at present approximately 300,000 miles of first- and second-order leveling.

DISTRIBUTION OF DATA

The triangulation data are issued in lithoprint form. The descriptions of stations are issued on loose-leaf sheets. Another series of sheets gives the latitude, longitude, and azimuth for the respective stations; and a third series of sheets gives the plane coordinate positions and grid azimuths for the various stations.

For the distribution of leveling data, the loose-leaf lithoprint method is also followed. The descriptions of bench marks and their elevations are lithoprinted on sheets about 8 by 11 inches in size.

These triangulation and leveling sketches, and data concerning triangulation stations and bench marks, are available for general issue and will be sent to those who request such information from the Director, U. S. Coast and Geodetic Survey, Washington 25, D. C., or any of the regional offices of the Bureau.

Comment and Discussion

The pages of SURVEYING AND MAPPING are open to a free and temperate discussion of all matters pertaining to the interests of the CONGRESS. It is the purpose of this Department to encourage comments on published material or the presentation of new ideas in an informal way. —EDITOR.

GROUND ELEVATIONS BY USE OF ELECTRONICS

GLEN B. WOOLLEY.*—Echo sounding, by means of which a vessel obtains a profile of the ocean bottom over which it is traversing, is now a common method of measuring ocean depths. When combined with radio acoustic ranging or Shoran for obtaining position the two essentials for making hydrographic surveys are provided.

Applying similar principles it should be possible to obtain ground elevations by electronic means for use in the office preparation of topographic maps. The following discussion attempts to point out how these principles might be utilized. It is realized that many difficulties may be encountered in the practical application of the proposed method, and it is therefore presented merely as a basis for discussion of its merits and feasibility.

The general theory of the method is as follows: If a horizontal plane of known elevation were established over a quadrangle to be mapped, and if from this plane a vast series of vertical lines were dropped to the earth's surface, and if the length and position of each of these lines were recorded, there would be enough information obtained to place a ground elevation at each point of contact.

To visualize the method, consider the following conditions: Let an airplane, flying at a nearly constant altitude, cover the quadrangle in question with a series of parallel lines of flight. Then let the airplane fly a second similar series normal to the first and in the same horizontal plane. This would form a cross-sectioning pattern over the area and would represent the horizontal plane of known elevation. It would then be necessary to set up a system whereby the horizontal positions of the airplane in its lines of flight could be recorded periodically, as well as to record its vertical fluctuations. To accomplish these, two radar sets would be required, each set operating on a different frequency. Each set would be mounted on a point of high ground of known geographical position and elevation.

The mechanical structure of the radar sets would have to be such as to record instantaneously and at regular time intervals both horizontal and vertical angles. The horizontal angle would be between the airplane and the base line formed by the two radar sets. The vertical angle would be between the airplane and the horizontal plane at each set. To account for the vertical fluctuations of the airplane, each set would have to record, by means of a stylus on a continuous graph, a continuous vertical angle.

The next step would be to get the ground elevations directly below the airplane in its lines of flight. To accomplish this task a third radar set operating on its

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individual frequency would be required. This set would be mounted within the airplane and would be so arranged mechanically as to record on a graph a continuous profile of the earth's surface directly below the airplane in its lines of flight. The set would have to be designed to transmit a directional beam perpendicular to the horizontal plane so that a true profile could be recorded.

These three individual units operating in unison would be aimed to locate and produce the necessary ground elevations.

Some additional conditions would be necessary for the complete operation of this system. A synchronized timing schedule would be established between each of the two ground stations and the airplane. A radio intercommunication system would also be necessary. And, to create a simplified method of plotting these elevations at the completion of the field survey, it would be necessary to have the recording apparatus of each of the three sets operate in unison and at a constant speed. The graphs of each machine could be divided vertically into equal units to represent units of time and a marker device included in the mechanism of each to mark the divisions required. The profile graph could also be ruled horizontally into equal divisions representing units of distance.

To visualize this system in operation consider the airplane about to begin on one of its flight lines. The first position or fix could represent the beginning of this line and be so arranged as to fall on one of the time divisions of the graphs which would simultaneously appear under the stylus of each machine. This could then be marked by the marker device as signaled from the airplane by radio. At this same instant the clock time could be observed and recorded in a field note book giving reference to the fix number. As the airplane proceeded along the flight line the succeeding fixes could be marked in a like manner. This would give a systematic series of locations with relation to time. The positions along the flight lines covering the whole quadrangle could be recorded in this manner giving sufficient data to plot them at scale on a base map.

Having accomplished the required field work it would then be necessary to process the recorded data for office use in order to plot the survey.

The required elevations could be scaled from the profile graph. These elevations will not be true since they will be affected by factors which are independent of the recording device. The largest of these would probably be the vertical fluctuation of the airplane. Other factors may be air temperature and humidity. The corrected scaled elevations subtracted from the elevation of the horizontal plane would give the true elevations.

The final step would be to plot on a radial plot or other required base map of the quadrangle the geographic positions of the two ground control radar sets. From these positions and the angles given in the recorded field data the airplane's positions at the fixes could be plotted successively. These positions connected in succession with straight lines would almost perfectly reproduce at map scale the original flight lines of the airplane. By means of spacing and timing, the correct ground elevations could be plotted on the base map at their true positions.

The elevations thus plotted could prove very helpful in the office interpretation of topographic relief and the drawing of contour lines. Through the use of stereoscopic equipment contour lines could be drawn by interpolation between parallel lines of elevations or the exact crossing of a contour line could be determined by reference to the elevation graph.

FONTANA RESERVOIR CAUSES GROUND SETTLEMENT

C. E. BLEE.*—Recently, measurements were made to determine the settlement of the ground in the vicinity of Fontana Dam (a part of the TVA system) due to the weight of the dam and of the impounded water. The dam has an over-all height of about 480 feet, and a net difference between maximum headwater and tailwater of about 440 feet.

The reservoir was filled for the first time in June of this year. Before the filling, a line of precise levels had connected the toe of the dam with certain bench marks of the U. S. Coast and Geodetic Survey located some 5½ miles away in airline and 8 miles by way of the access to the dam. This line was surveyed with a first-order U. S. Coast and Geodetic Survey model dumpy level and invar-strip level rods. The leveling was executed during daylight in accordance with first-order methods.

Similar levels were run during June of this year. The measurements showed that bench marks at the toe of the dam were lower than before the filling of the reservoir by 0.082 foot, almost exactly 1 inch. The probable error of the measurement was calculated as 0.009 foot. Inasmuch as the orginal reference line was run after the concrete of the dam had been substantially placed, the settlement reflects the influence of the weight of the water in the reservoir.

At a distance of three-fourths of a mile from the dam the change of level was 0.036 foot or a little less than one-half the maximum. From this point on the measured settlement gradually diminished to zero at the reference point.

Similar surveys on top of the dam showed that at the easterly end there was a drop of approximately 0.03 foot as compared with the center of the dam, at which point the regional levels had been tied in. Inasmuch as the dam was built at a sharp bend in the river and the east abutment is on the convex bank, it would appear that the weight of the reservoir water would have a somewhat greater effect at this end of the dam than in the center or at the opposite end.

These observations illustrate the fact that there is no such thing as absolute fixity of foundation. They also appear to be in substantial accord with observations of similar settlement as reported from Boulder Dam.—*Engineering News-Record*, October 3, 1946.

* Chief Engineer, Tennessee Valley Authority.

"SURVEYING AND MAPPING" REACTIONS

I had no knowledge that such an interesting journal was being published, and have registered as a member in the American Congress on Surveying and Mapping.

The articles in SURVEYING AND MAPPING were very interesting, especially the report on "Postwar Opportunities in Private Practice." Some of the other articles were of particular interest to me also, because I have worked for the U. S. Coast and Geodetic Survey on triangulation and helped to start the Cleveland Geodetic Survey. Please feel free to call on me for any help you may need in the promotion of our profession.—JOSEPH E. MCSTEEN, Registered Surveyor, University Heights, Ohio.

CONGRESS NEWS

Notice to Members

(*Especially field men and those who frequently change address*)

TO AVOID delay and confusion in delivery of the Journal, members are urged to furnish change of address notices promptly to the Acting Secretary, Box 470, Benjamin Franklin Station, Washington 4, D. C. In some instances copies have been returned to Washington headquarters again and again because of lack of latest forwarding address.

Attention is called to the fact that the second-class mailing privilege, under which the Journal is mailed, allows delivery to one address only, and does not allow forwarding without additional postage. Therefore, even in cases where mail is being forwarded from a permanent address, additional postage should be affixed, otherwise the Journal is returned to the Washington office under penalty postage.

It should also be remembered that the normal forwarding notice to the Post Office *covers only first-class mail.* Cards are furnished free by the Post Office for notifying changes of address. Notify us at the same time so we can keep your address up to date.

Members who classify as itinerants should send us address verification cards to determine their current addresses when the Journal is about ready for distribution, which normally should be March, June, September, and December.

Your co-operation will help bring the Journal to you on time.

New Chairman of Publications Committee

Mr. Jerome O. Kilmartin, Assistant Chief of the Map Information Office, U. S. Geological Survey, has been appointed Chairman of the Publications Committee, succeeding Mr. George D. Whitmore, who was forced to relinquish the office because of press of other duties. The Publications Committee will have direct responsibility for the procurement of articles and other publication items, as well as for preliminary editing. To carry out the increased responsibilities of the Committee, Mr. Kilmartin will need volunteers to serve as associate editors in the various technical fields. He will also need contact men in each of the major federal agencies, and in each of the larger commercial organizations in the surveying and mapping field. Members of the Congress can be of great assistance to Mr. Kilmartin by helping him to get the proper persons to serve in these various capacities.

The Committee's objective is to have in reserve at all times a sufficient number

of original articles on a variety of subjects, in order that each issue may be "balanced" in content. This will require a continuous backlog of 20 to 30 articles.

The active co-operation of the members in furnishing the Publications Committee and the Editor of SURVEYING AND MAPPING with articles or other material for publication is earnestly solicited. We can keep the Journal at its present high standard and maintain a reasonable publication schedule if we have that support.

FRANK S. BORDEN,
President

New Officers Elected for Control Surveys Division

On approval of the Executive Committee of the Congress, ballots and letters announcing the election of new officers for the Control Surveys Division were sent on December 17, 1946, to about 125 members of the Congress who were believed to have a real interest in control surveys. It was not considered a justifiable expense to send letters to all members.

The Committee of Tellers named to count the ballots, composed of Norman F. Braaten, Ernest J. Parkin, and Frank L. Culley, *Chairman*, announced the election of the following officers, to serve from the time of the election:

Chairman:	Comdr. H. W. Hemple, Chief, Division of Geodesy, U. S. Coast and Geodetic Survey, Washington, D. C.
Vice-Chairman:	Prof. O. J. Marshall, Department of Civil Engineering, Ohio State University, Columbus, Ohio
Secy.-Treasurer:	Mr. Floyd W. Hough, Chief, Geodetic Division, Army Map Service, Brooks Lane, Maryland
Associate Editor:	Mr. R. M. Wilson, Chief, Geodesy and Control Section, Topographic Branch, U. S. Geological Survey, Washington, D. C.

Members of the Nominating Committee were George D. Whitmore, J. H. Brittain, David L. Mills, H. S. Rappleye, and Walter S. Dix, *Chairman*.

CLEMENT L. GARNER

CAN YOU TOP THIS?

Mr. Francis J. Ortiz, a cartographic engineer in the U. S. Coast and Geodetic Survey, has enrolled 30 new members in the Congress and is still "bringing them in."

Volume VII, Nos. 1 and 2

Due to an unavoidable delay in the publication of this issue of SURVEYING AND MAPPING, it has been found advisable to combine Nos. 1 and 2 of Volume VII into a single enlarged issue. This, however, does not establish a precedent for future issues, and members may look forward to a resumption of our regular publication schedule of four issues a year.

THE EDITOR

Congress Emblem Available

This is the official emblem of the American Congress on Surveying and Mapping. Designed in blue, white, and gold, in the size shown, it forms a simple, yet attractive pin.

The emblem is immediately available to members in a gold-plate finish with safety-clasp at the price of $1.50.

Make check or money order payable to American Congress on Surveying and Mapping, and send to Murray Y. Poling, Chairman, Emblem Committee, Room 2814–B, Department of Commerce Building, Washington 25, D. C.

Wear the Emblem as Your Congress Identification

* * *

Obituary

HENRY GODFREY AVERS, Chief Mathematician, Division of Geodesy, U. S. Coast and Geodetic Survey, passed away at his home in Washington, D. C., on January 19, 1947, after an illness of several months. He entered the government service as a geodetic computer in 1908 and continued with the Division of Geodesy for the remainder of his life, becoming Chief Mathematician in 1924. At various times between 1917 and 1922 he was in the field in charge of precise leveling in seven states.

He was born at Elmore, Ohio, March 6, 1886 and was educated in the public schools of Elmore, Metropolitan Business College at Toledo, Ohio Northern University, and George Washington University, taking his A.B. degree from the last-named institution in 1913.

Mr. Avers was active in many scientific and technical societies and was a member of the American Congress on Surveying and Mapping. He was Treasurer of the Washington Academy of Sciences, Secretary of the Division of Surveying and Mapping of the American Society of Civil Engineers, and both Secretary and Chairman of the Section of Geodesy of the American Geophysical Union. In 1926 and again in 1929 he was a member of the National Geographic Society Committee of Experts which examined and passed upon the records of Commander Richard E. Byrd in connection with his flights over the North and South Poles.

Mr. Avers was the author of U. S. Coast and Geodetic Survey Special Publication No. 140, Manual of First-Order Leveling, and also of numerous scientific and technical articles. His knowledge of precision leveling included not only a thorough mastery of the computation and adjustment of geodetic leveling records but first-hand experience with the field work as well. His death cut short an active career in the field of control surveying.

He is survived by his widow, a brother, and two sisters.

HOWARD S. RAPPLEYE

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Aids to Geographical Research

IN 1923 the American Geographical Society published as its *Research Series No. 10* "Aids to Geographical Research: Bibliographies and Periodicals," by John Kirtland Wright, at that time Librarian of the Society. A completely revised edition by Dr. Wright, now Director, and the late Elizabeth T. Platt, Librarian of the Society from 1937 until her death in 1943, is scheduled for publication this spring by the Columbia University Press as Number 22 of the Society's *Research Series*. Designed particularly to serve advanced students and professional workers in geography, it will deal not only with bibliographies and periodicals but also with a selection of atlases, gazetteers, and other reference books of geographical value and will contain, in addition, a classified check list of American professional geographers, libraries containing collections of geographical material, and institutions where geographical research is in progress.—*Geographical Review*, January, 1947.